

# EFFECTS OF DISTURBANCE ON KILLER WHALES

David Bain,  
University of Washington

# **Introduction**

**Sources of Disturbance**

**Mechanisms of Impact**

# **Methods**

**Observation**

**Experimentation**

# **Results**

**Behavior States**

**Surface Active Behavior**

**Movement Patterns**

**Effects of mid-frequency sonar**

# **Discussion**

**Zones of Influence**

**Effects on foraging efficiency**

**Population Scale Effects**

**Management Options**

# Sources of Disturbance

- Explosives
- Airguns
- Mid-Frequency Sonar
- LFA Sonar
- Acoustic Tomography
- Industrial
- Acoustic Harassment/Deterrent Devices
- Tourist Vessels
- Commercial Fishing
- Freight Traffic
- Aircraft
- Biological
- Physical

# Mechanisms

- Collisions with vessels
- Pollution
- Noise
- Physical presence
- Stress

# Noise Impact Mechanisms

- Masking
- Threshold Shifts
- Displacement
  - Excess Energy Expenditure
  - Impaired Foraging Efficiency
- Behavioral Changes
- Effects on Prey

# Observations of focal whales

- land-based
- theodolite (objective and repeatable)
- measure behavior with no boats around
- compare to behavior with different levels of boat activity (number, proximity, operating practices)



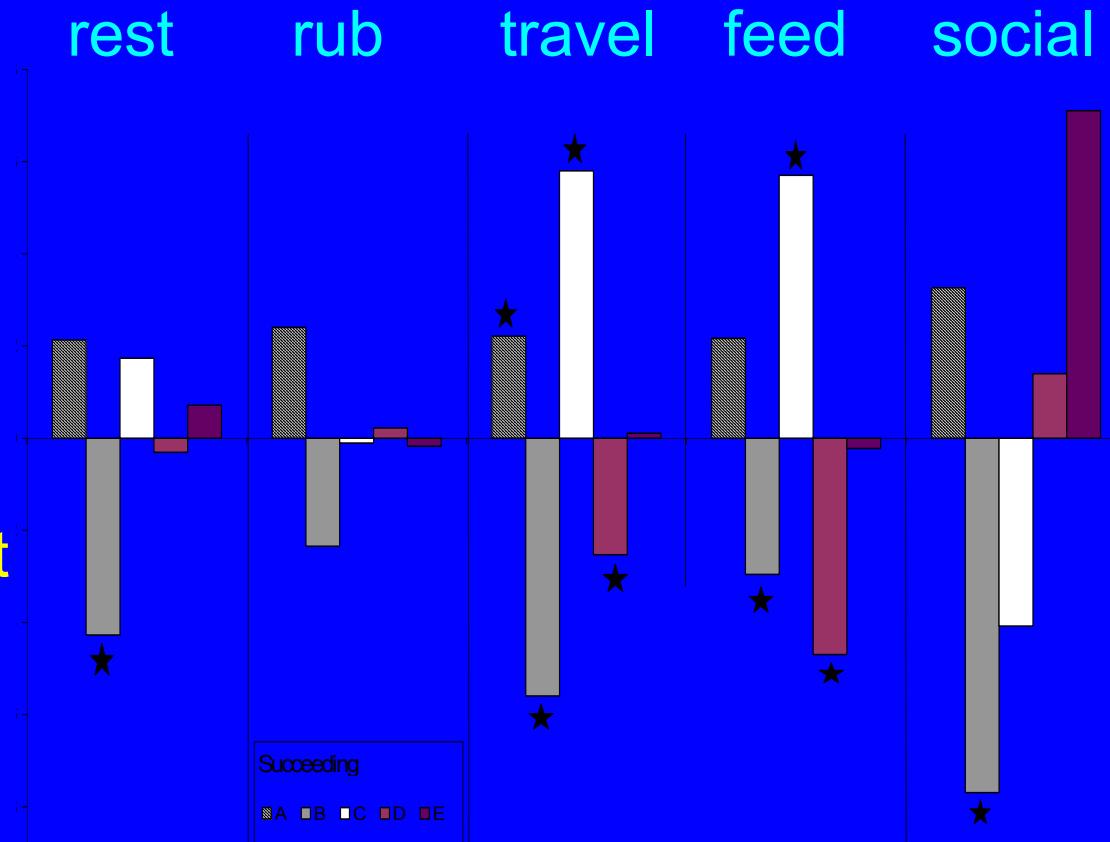
# Experiments on focal whales



- observe a whale for 20min without boats
- approach focal with experimental boat
- parallel the whale at 100m for 20min
- compare pre-exposure, exposure, and post-exposure data

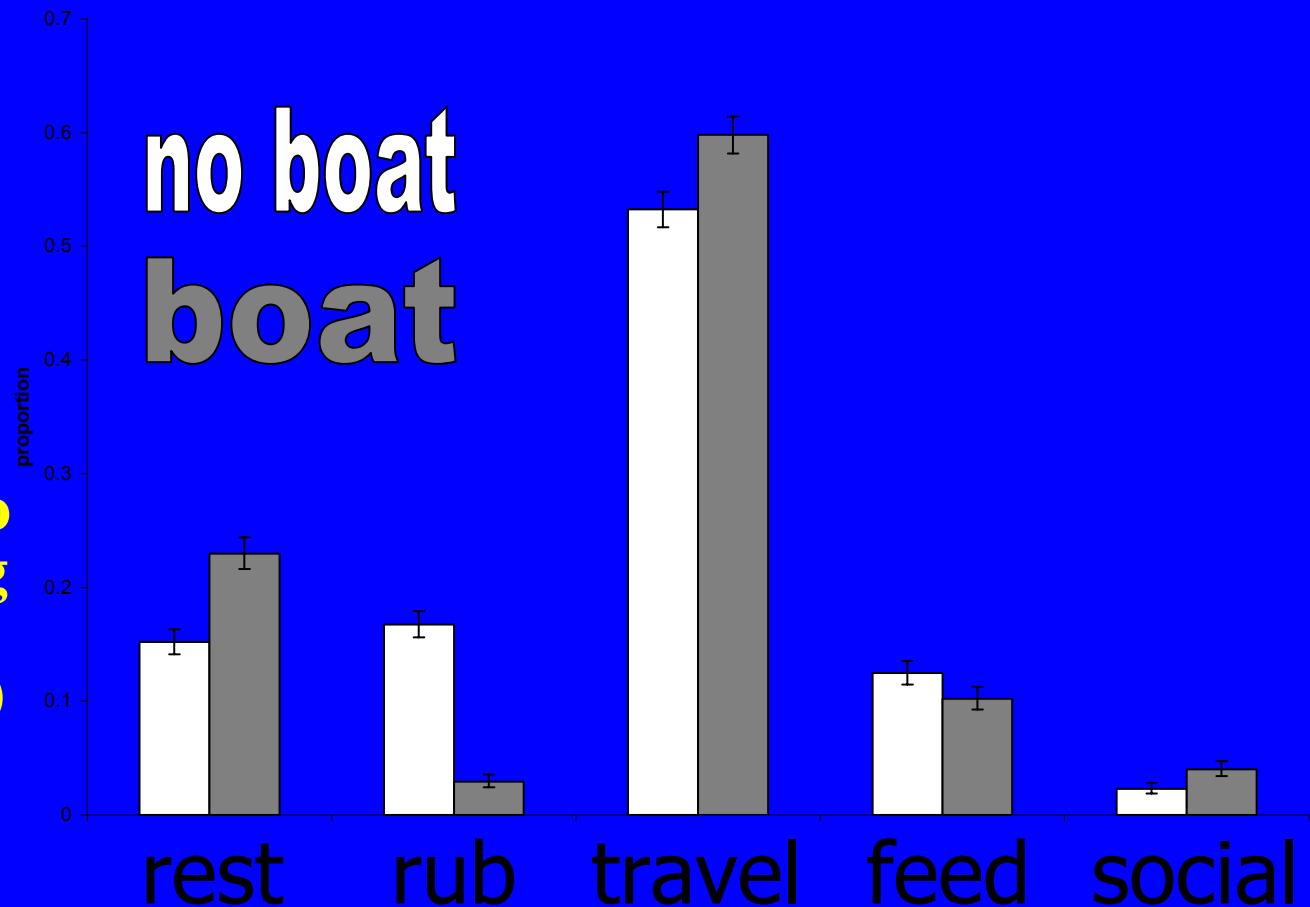
# Sampling all whales, all activities

- 15min scans – 8yr
- no focal bias
- Markov-chain modeling
- whales likelier to stop feeding after 15min with boats present than absent
- not all activities equally vulnerable to disturbance

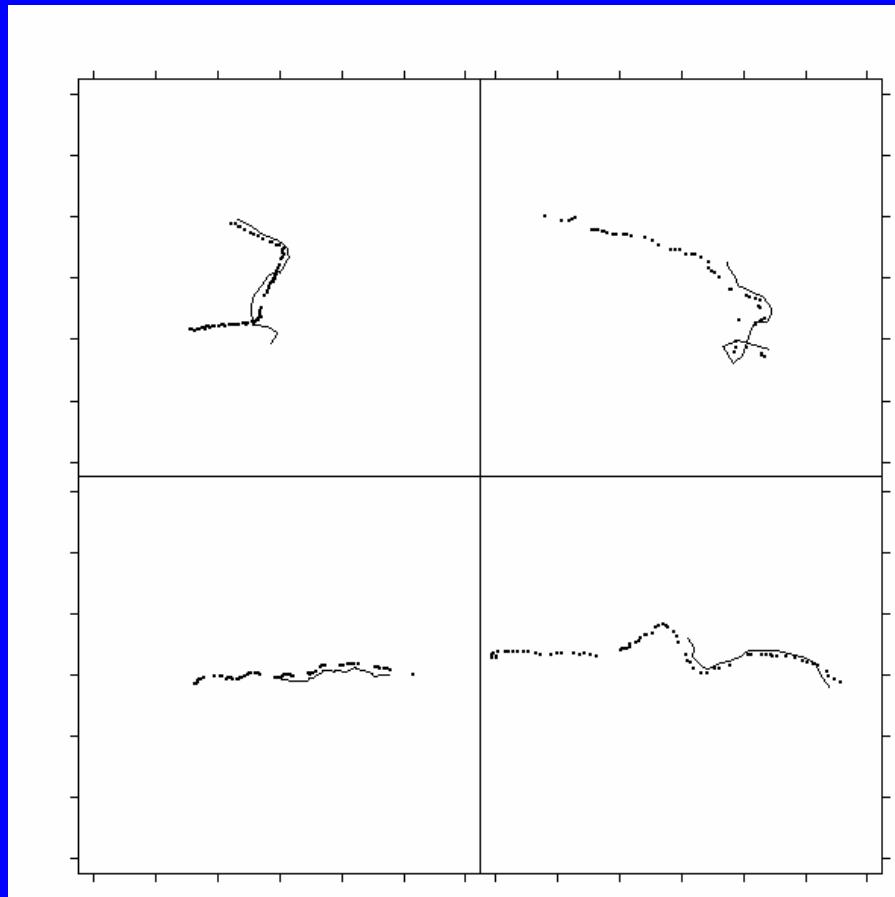
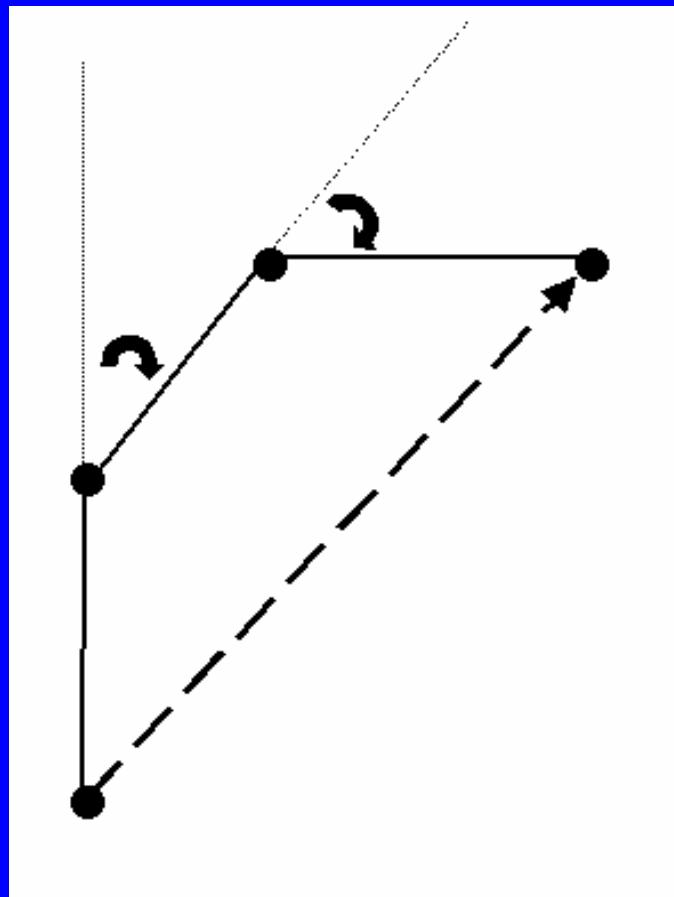


# Effect of boats on activity budgets

- stationary distribution = unbiased activity budget
- activity budgets differ
- boats cut into whales' feeding budget (and beach rubbing)

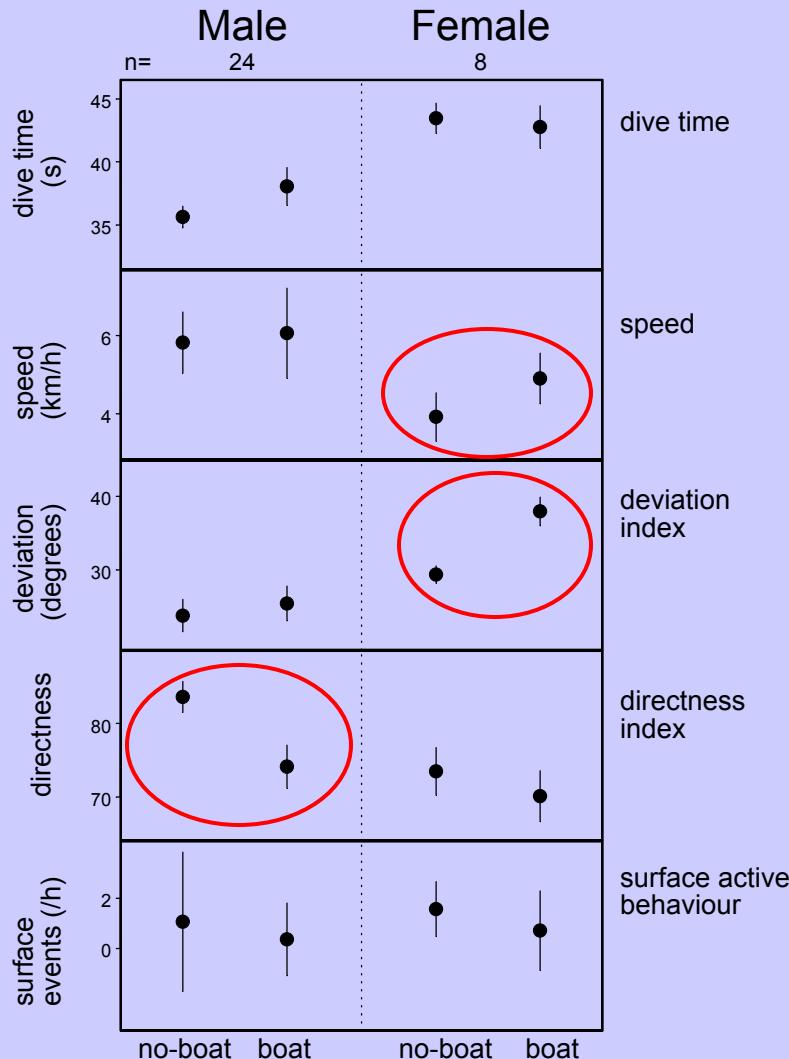


# Surfacing Patterns



··· whale  
— boat

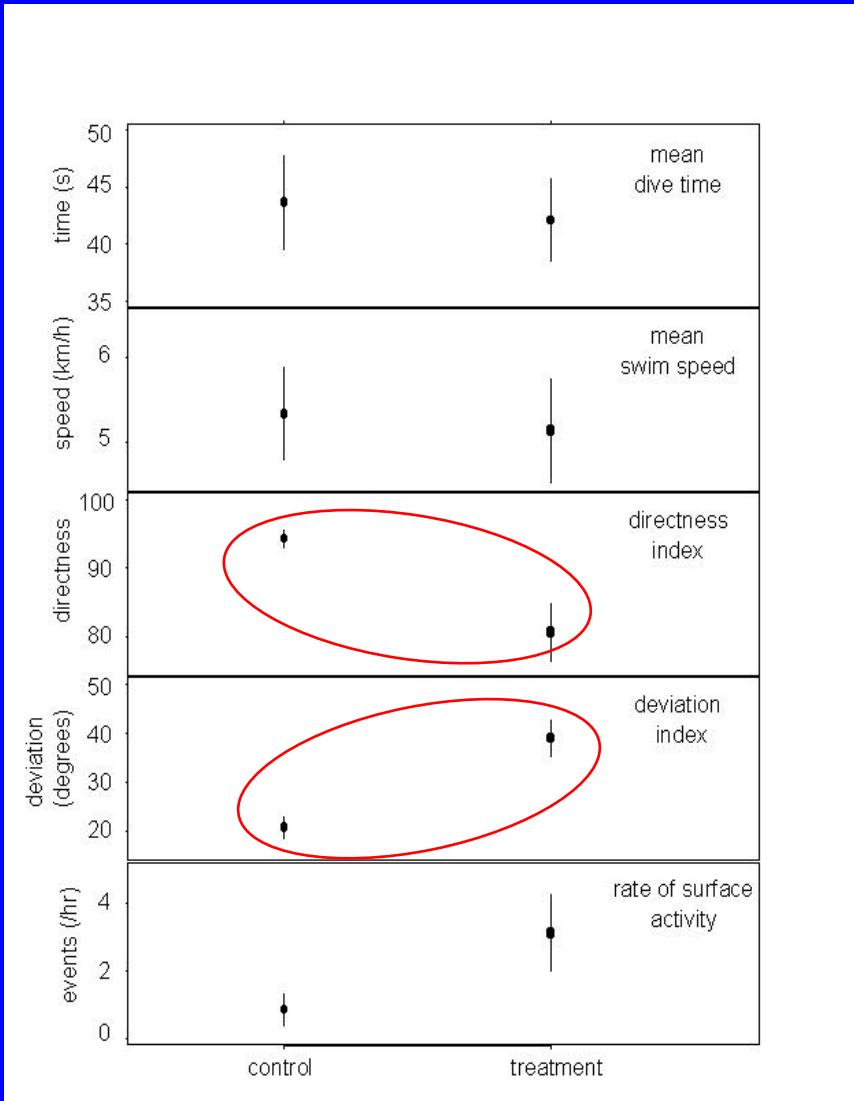
# So what?



- not all behaviors changed
- results consistent with *horizontal avoidance*
- swim 13% farther to get where they need to go
- that may cost energy

Williams et al. 2002a

# Speed Matters

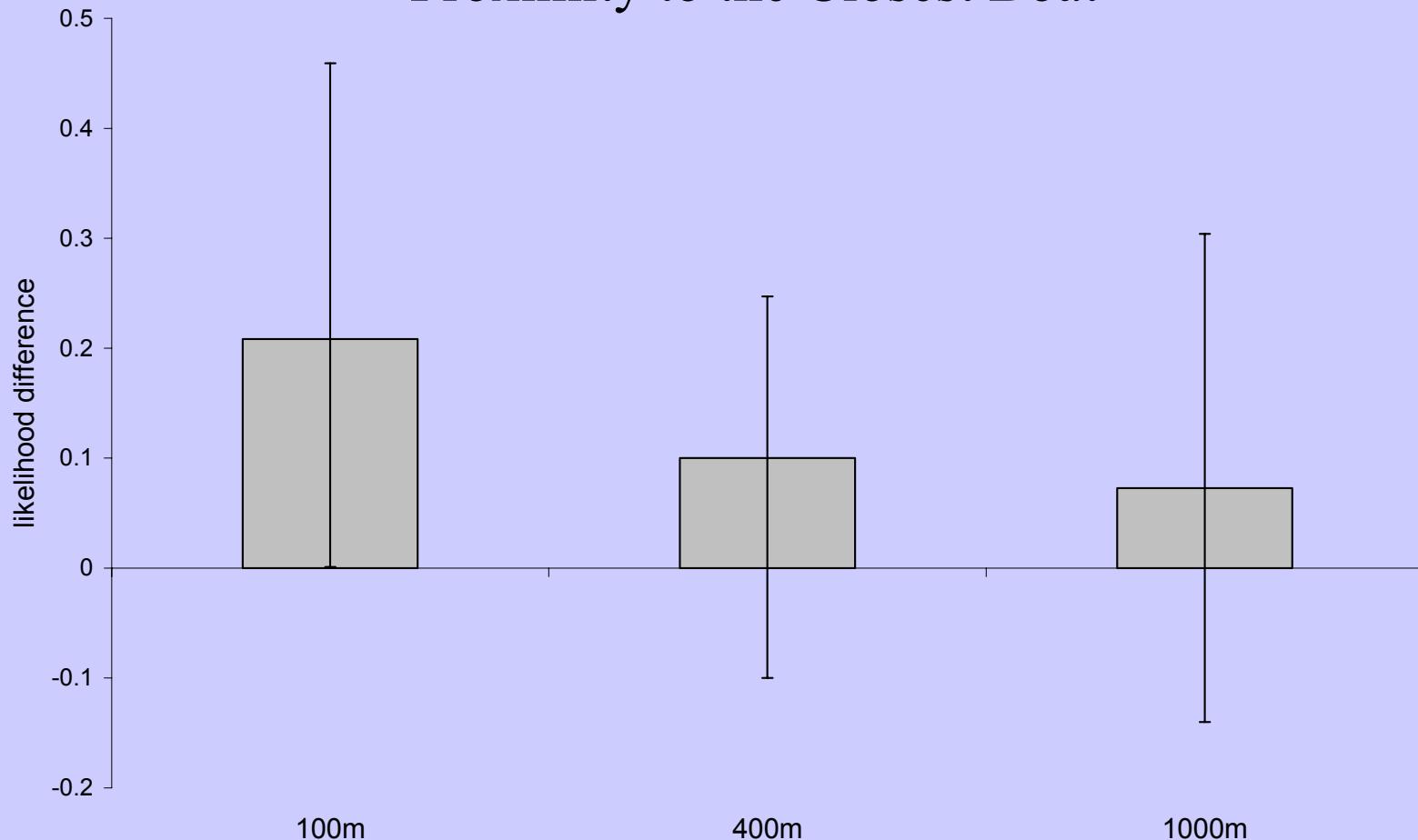


- whales used the same, but more obvious, response as to a paralleling zodiac
- response to leapfrogging at ~150m was detectable with observations on only 10 animals

(Williams *et al.* 2002b)

# Distance Matters

Change in Probability of Feeding as a Function of  
Proximity to the Closest Boat



# Distance Matters

(Southern Residents 2003)

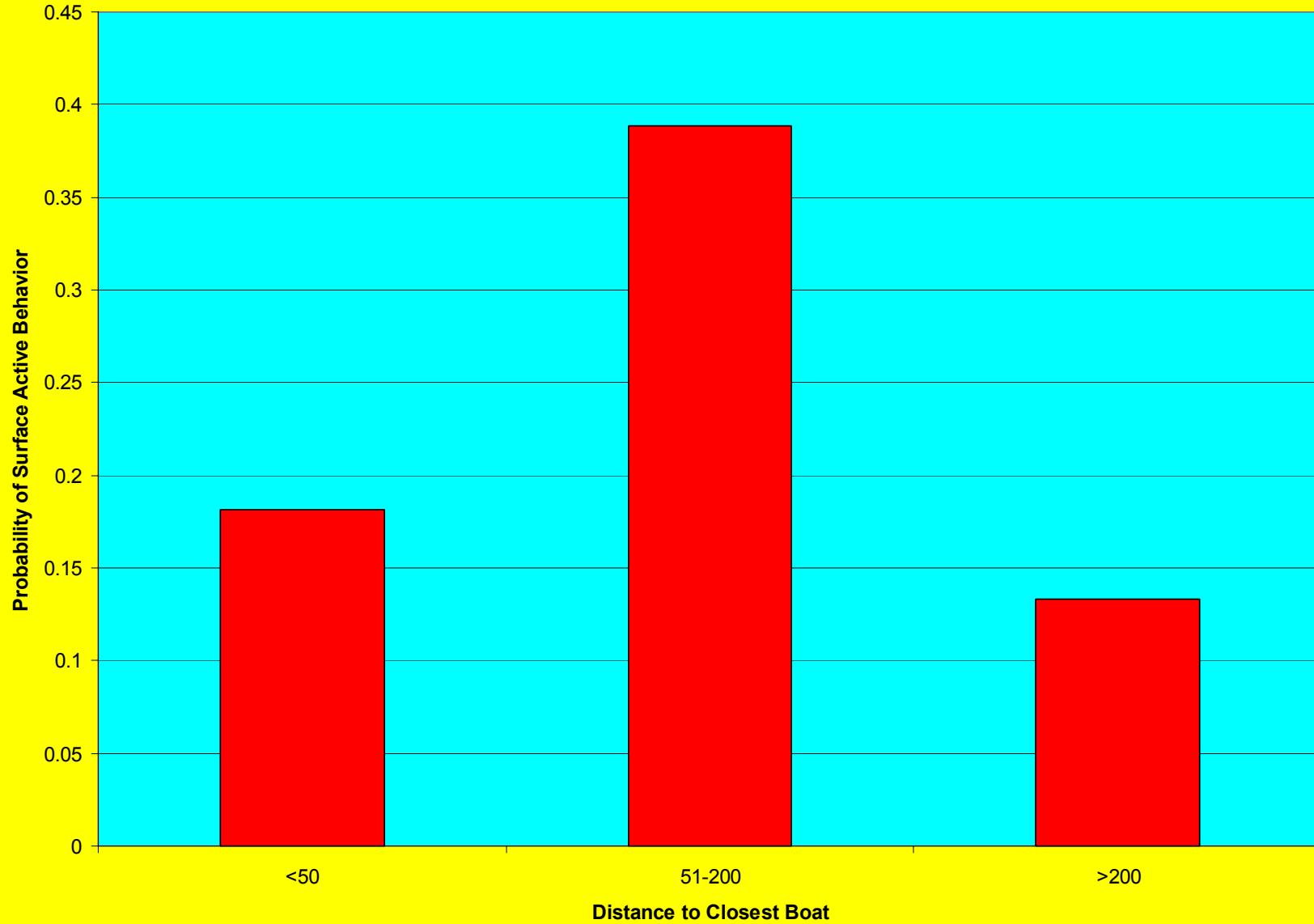
DISTANCE	<400	>400
Dive Time	56.2	44.2
Speed	6174	6462
Deviation	29.3	23.4
Directness	74.2	77.8
Surface Active	0.658	2.857

significantly different

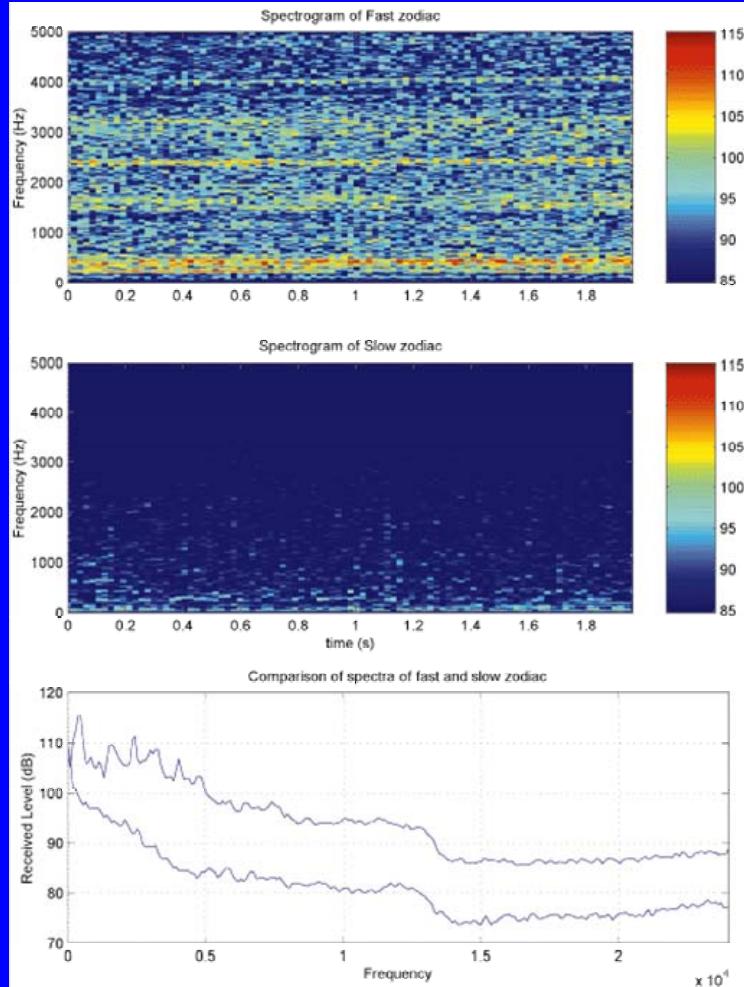
non-significant but in same direction as Northern Residents

# Distance Matters

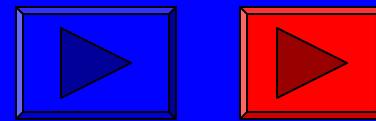
Surface Active Behavior as a Function of Observing Distance (SR 2003)



# Why is leapfrogging so disturbing?

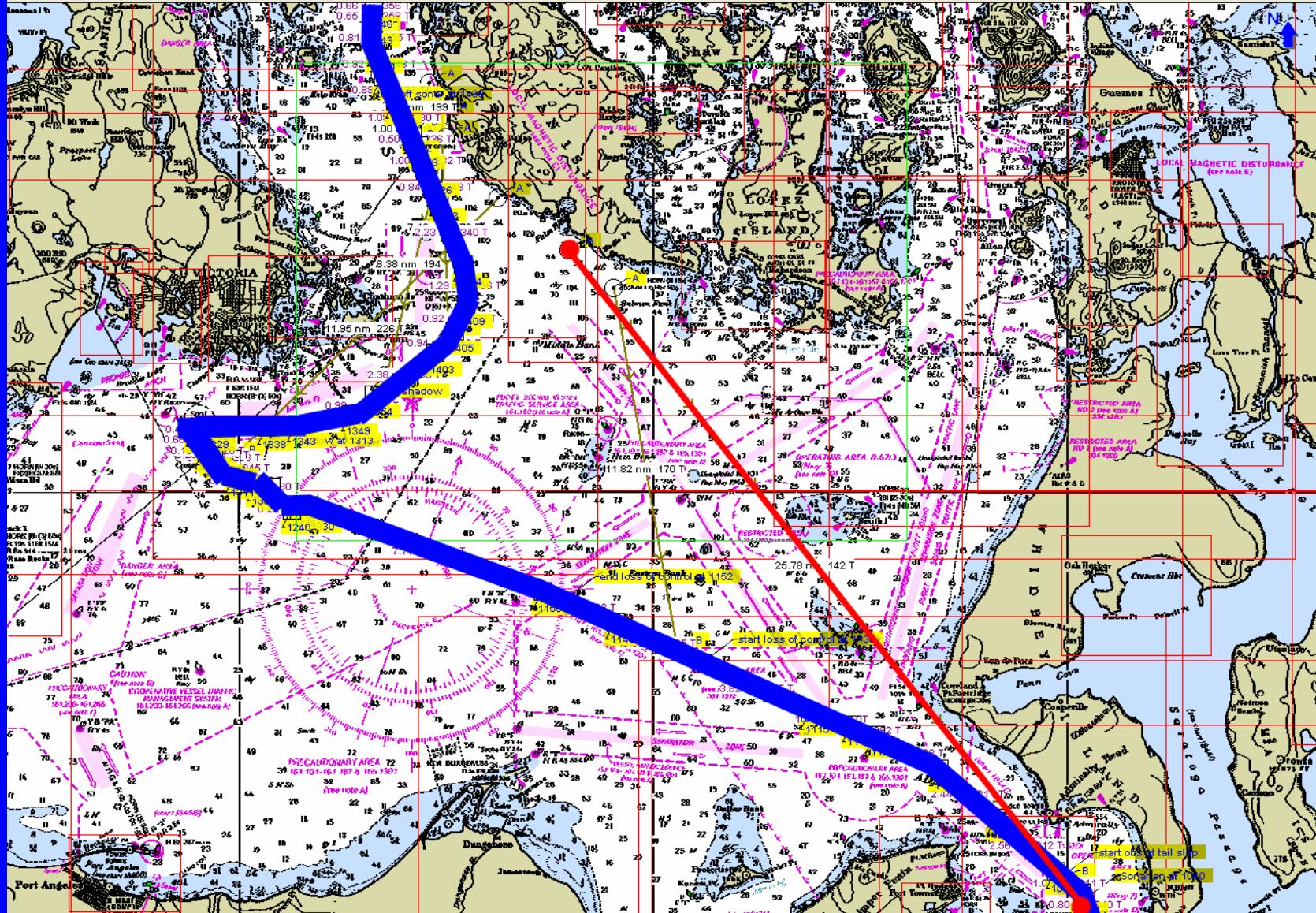


- when an outboard speeds up, noise gets louder, and higher in frequency
- noise placed directly in front of whale, which causes most masking
- received noise of fast boat at 500m equaled slow boat at 100m



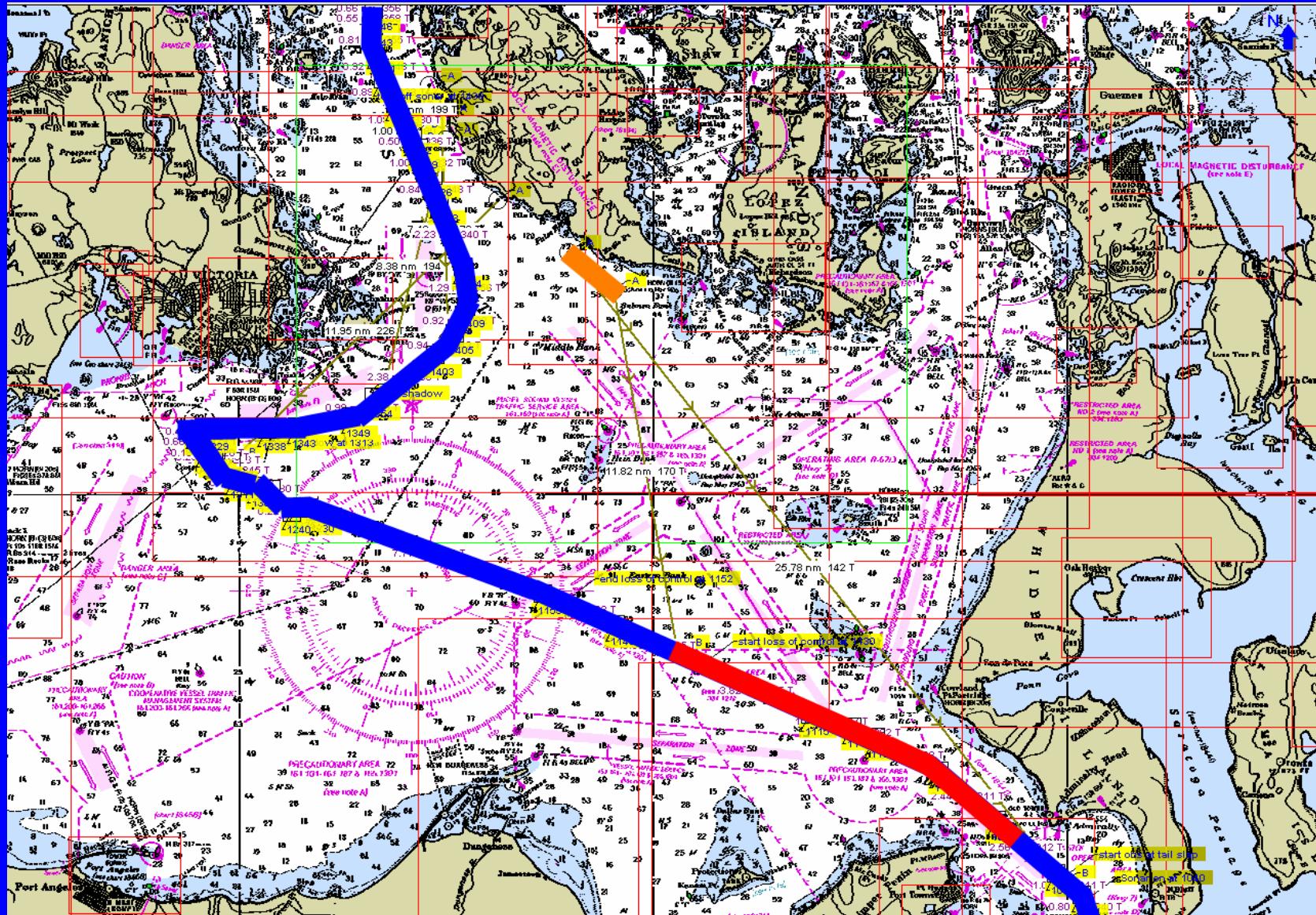
# Deep Water Path Established Tail Slap

Distance = 47 km, 26 nm  
Time: 1047



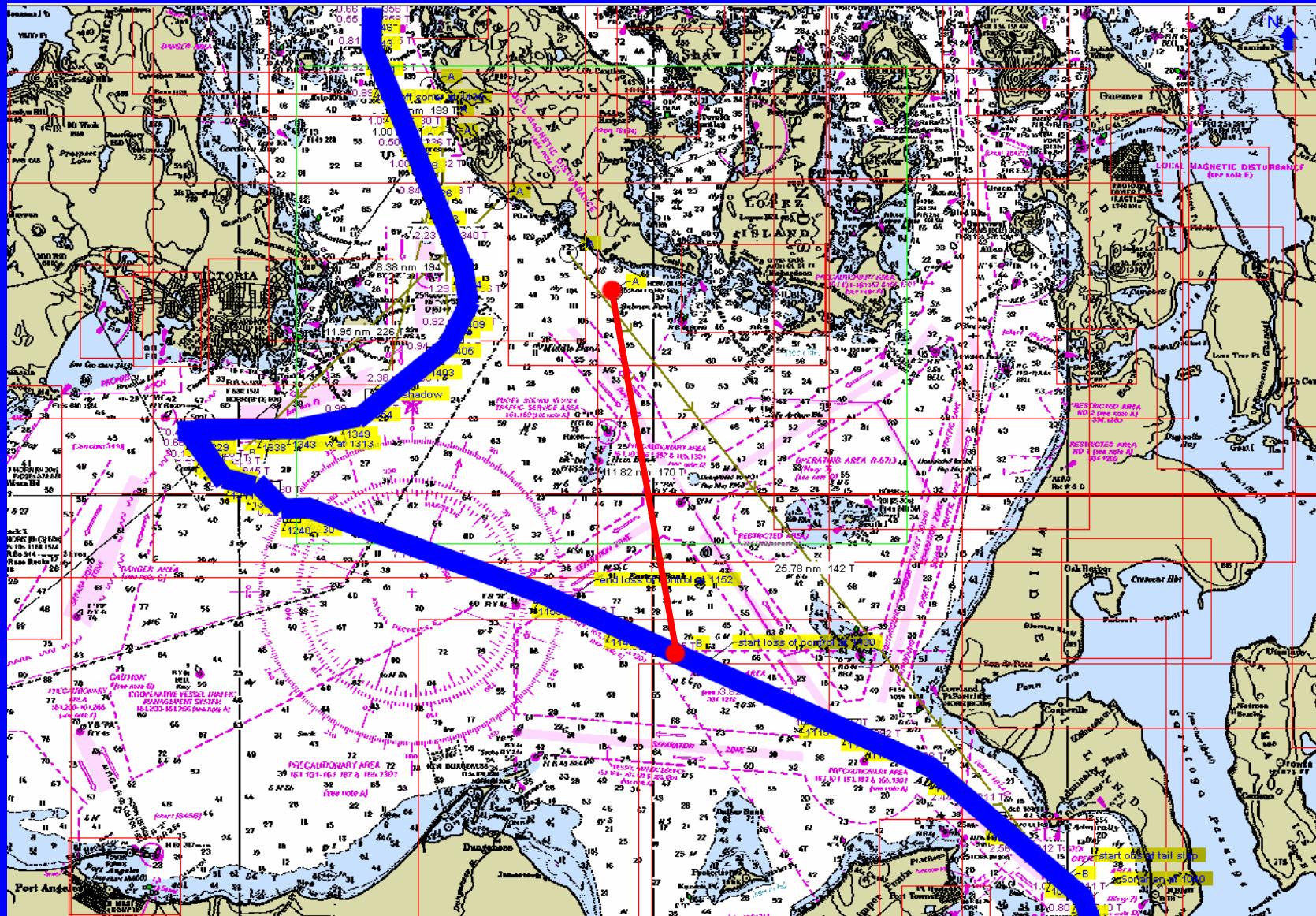
No Deep Water Path  
J Pod behaving normally

Distance = 47-22 km, 26-12 nm  
Time: 1047-1134



Deep water path established  
J Pod turns to move away

Distance = 22 km, 12 nm  
Time: 1134

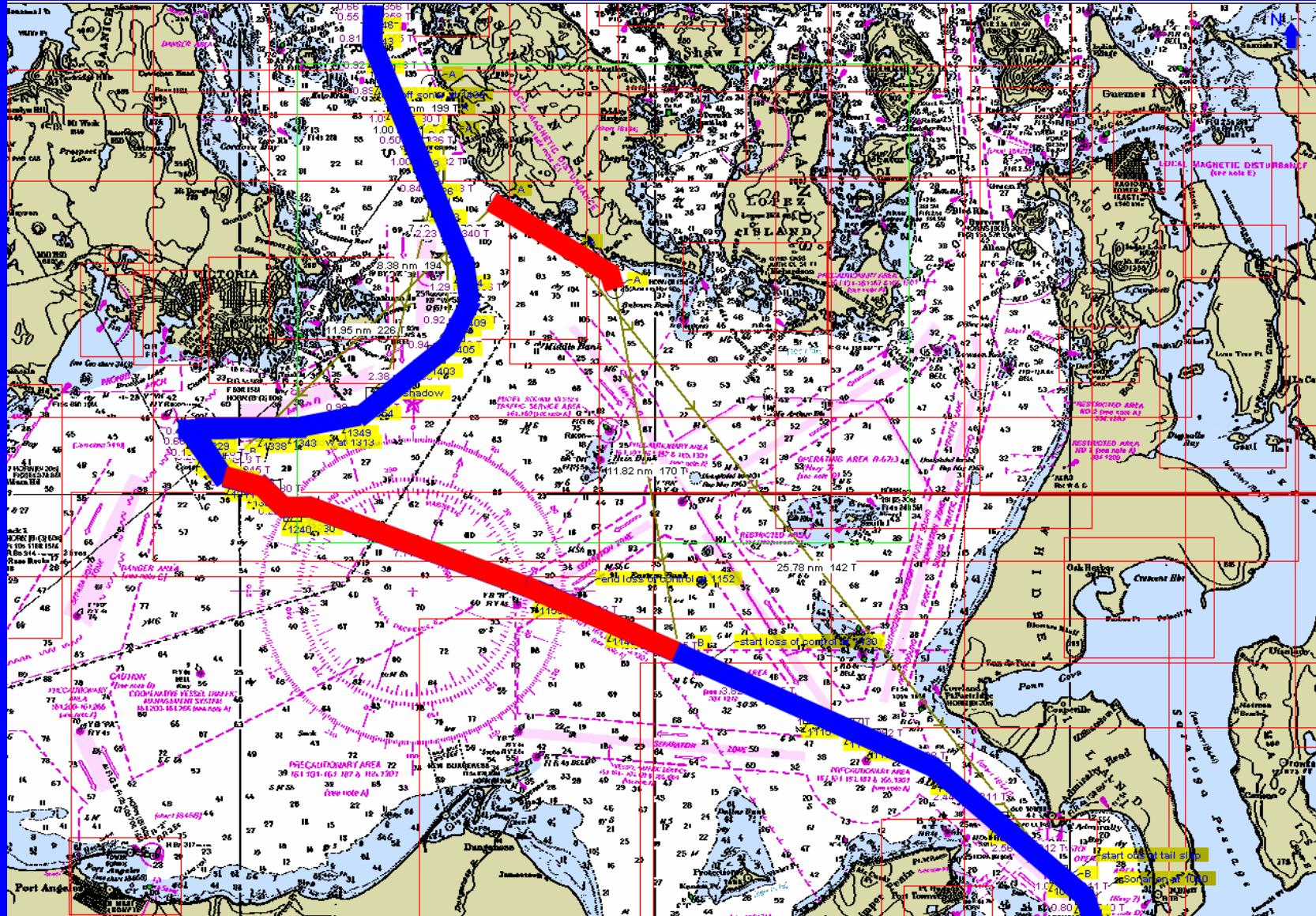


# Deep Water Path

J Pod behaving abnormally

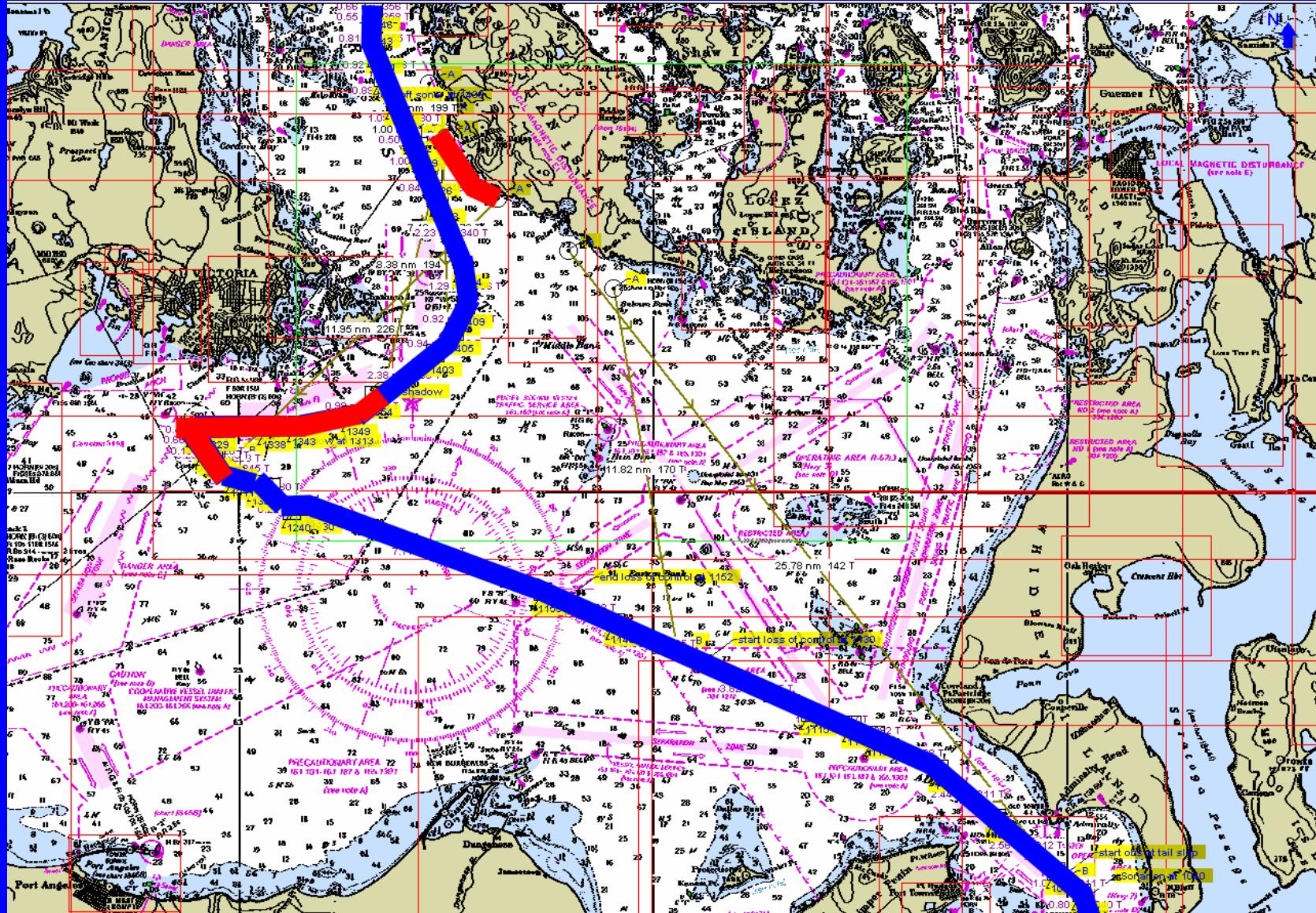
Distance = 18-22 km, 10-12 nm

Time: 1134-1314



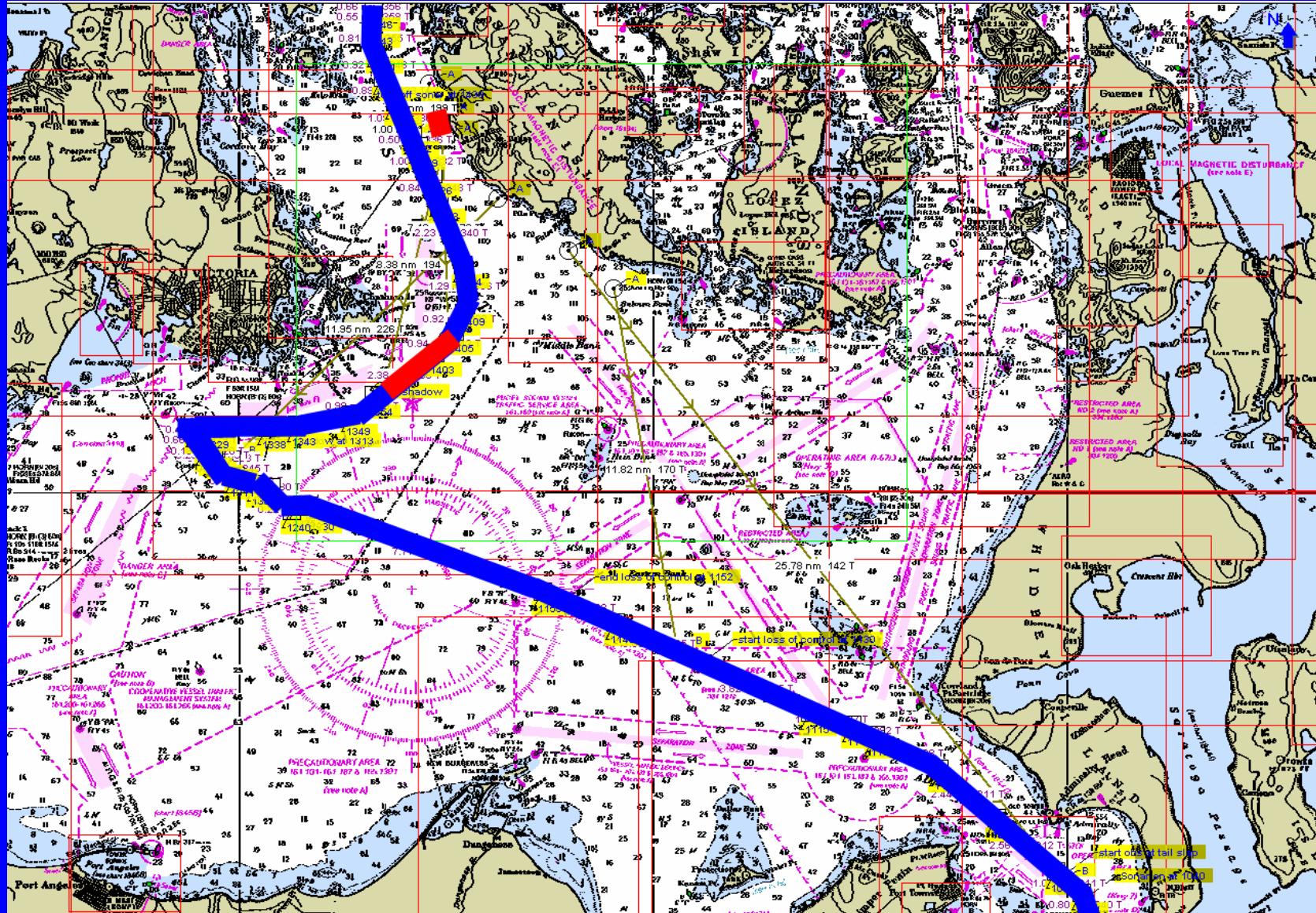
No Deep Water Path  
J Pod normal (slow, spread)

Distance = 15-22 km, 8-12 nm  
Time: 1314-1355



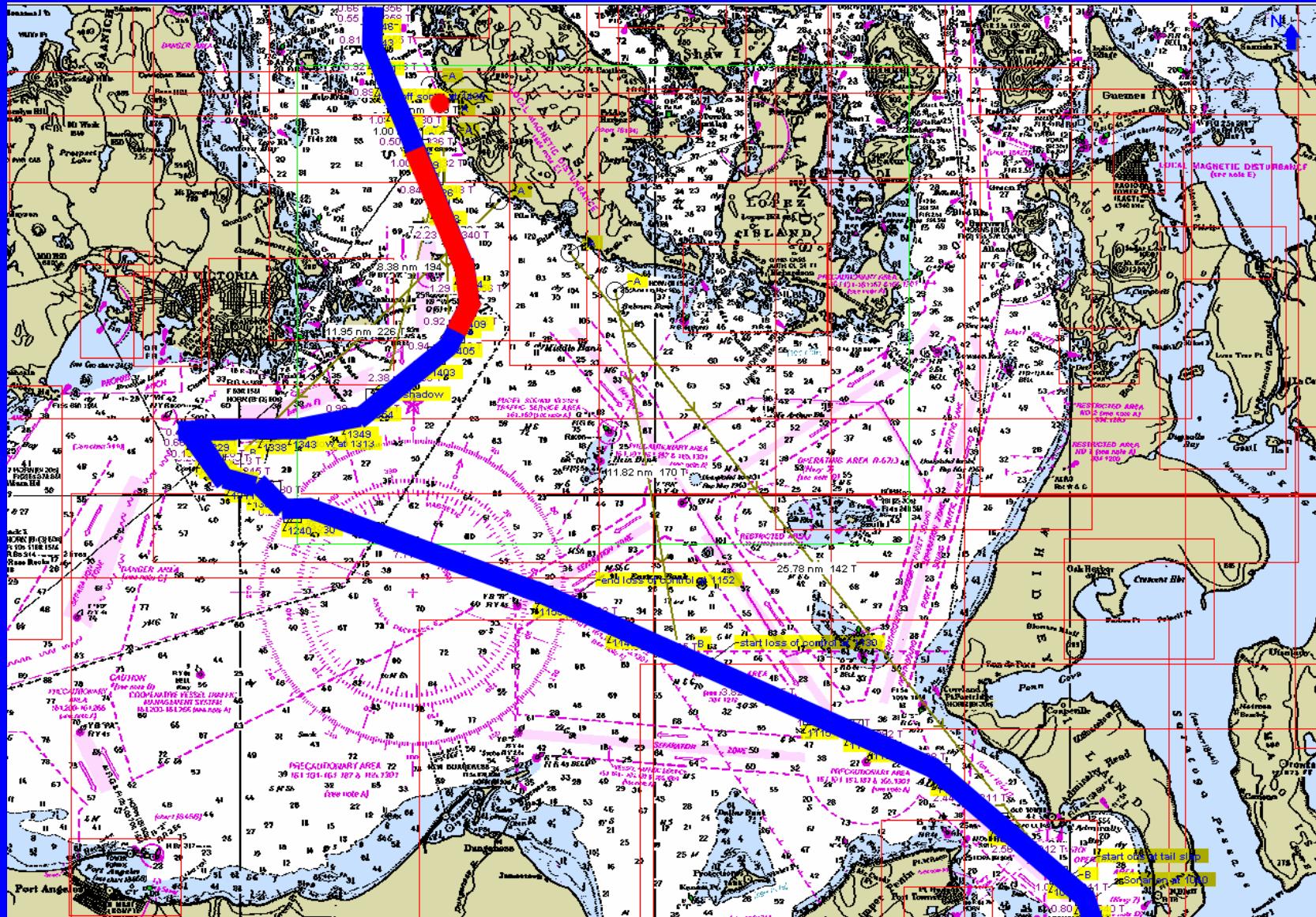
# Deep Water Path J Pod Abnormal

Distance = 13-15 km, 7-8 nm  
Time: 1355-1407



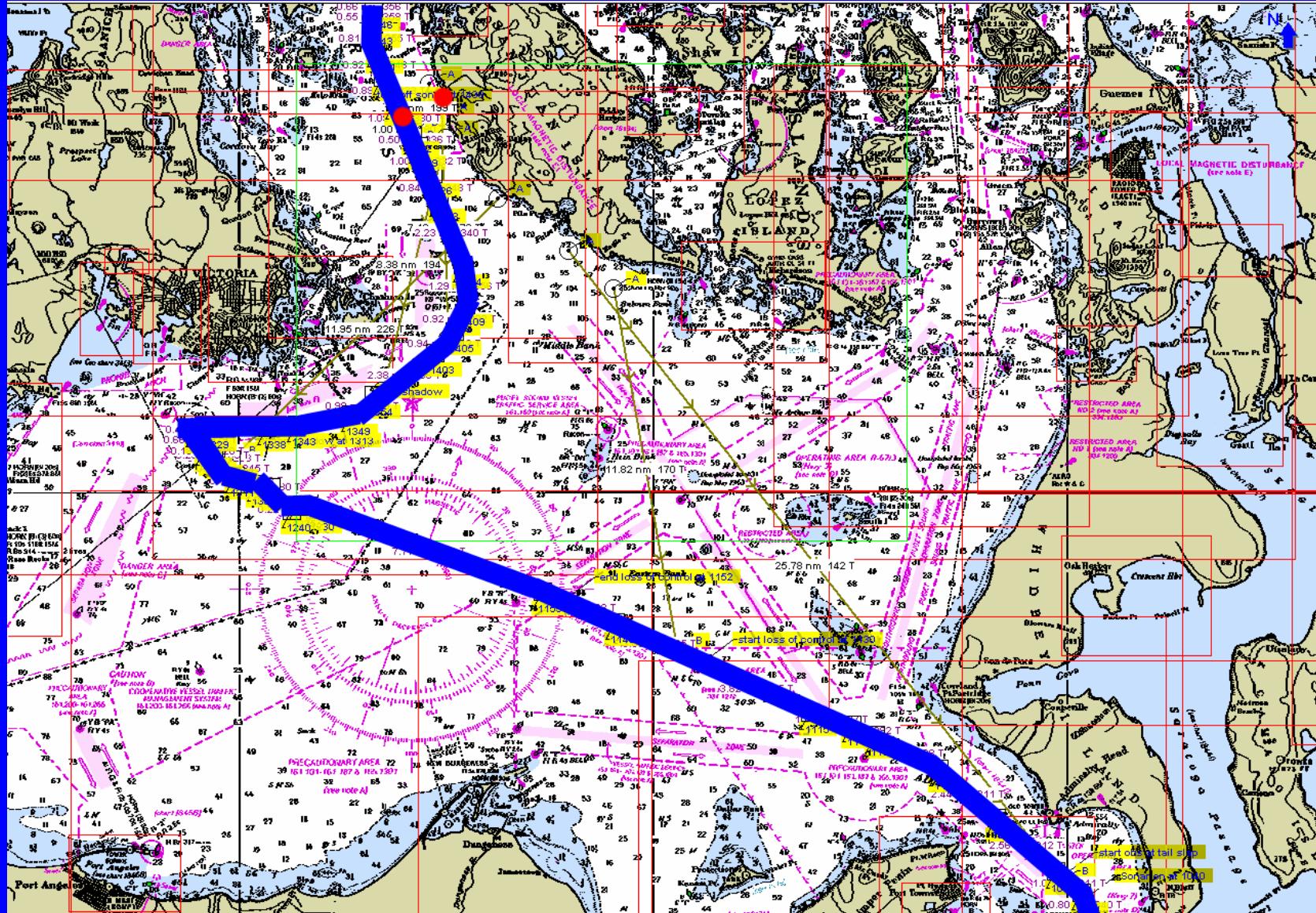
No Deep Water Path  
J Pod staying in shadow zone

Distance = 4-13 km, 2-7 nm  
Time: 1407-1432



# Closest approach J Pod splitting

Distance = 3 km, 1.7 nm  
Time: 1432

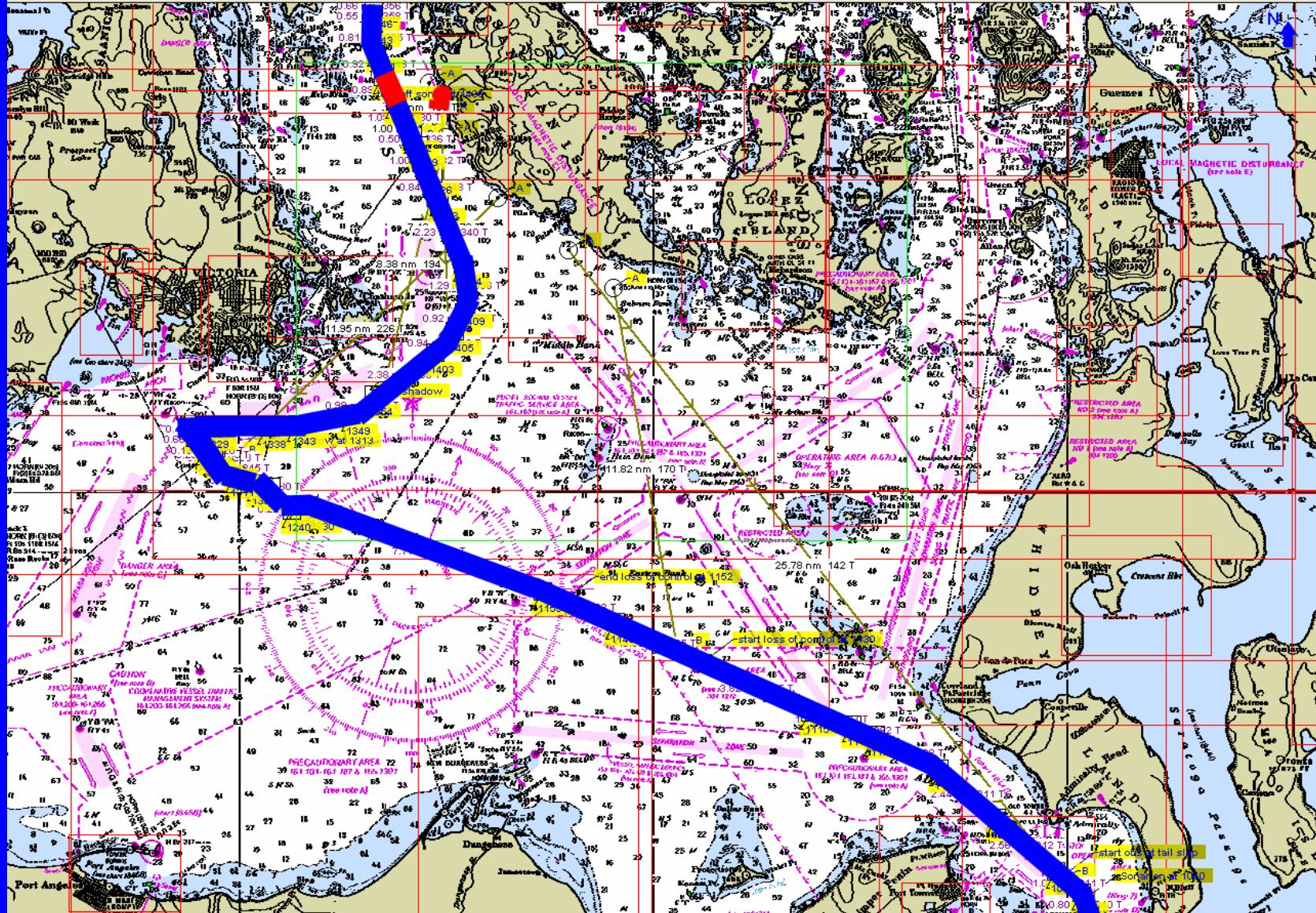


Shoup moving away

Distance = 3-4 km, 2 nm

J Pod splitting, part moving away

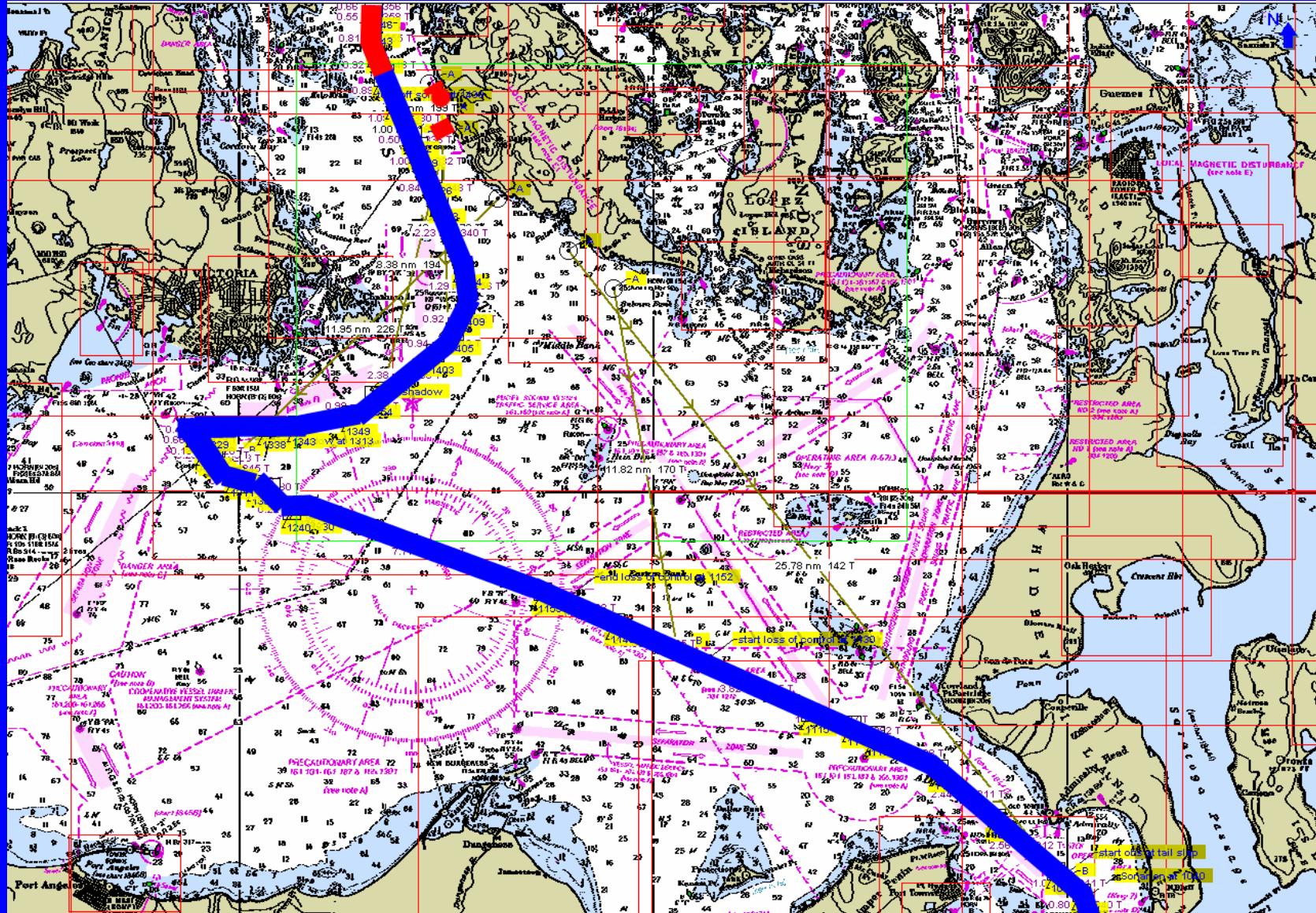
Time: 1432-1438

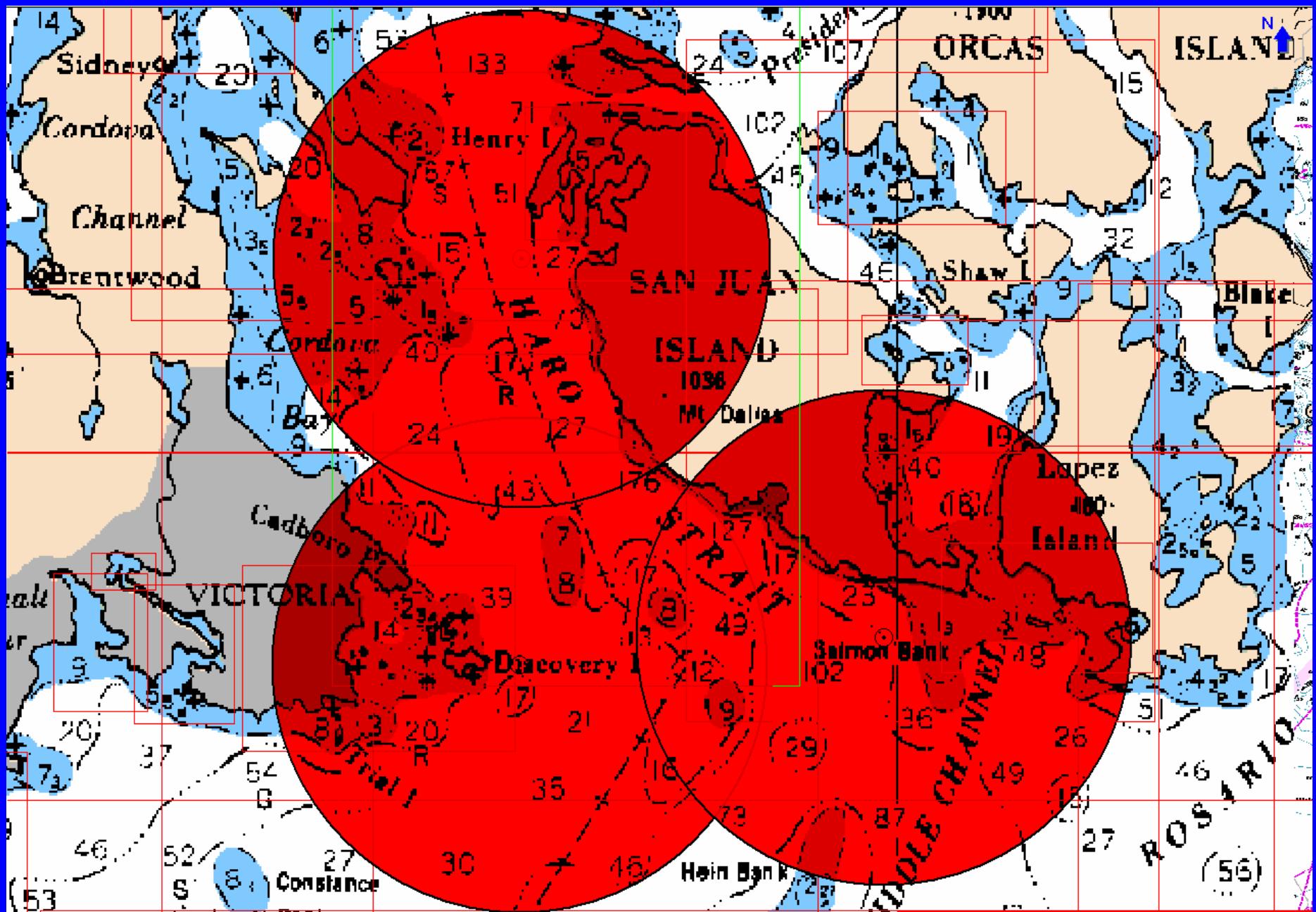


Sonar off

Distance = 4+ km, 2+ nm

J Pod split, moving offshore, spreading out Time: 1438-1452





Except for determine your place of destination, these charts are designed to 200 fathoms depth or less, and do not purport to delineate the limits of Juan de Fuca and Strait of Georgia waters, but are not intended in any way to suggest authority to alter the applicable rules of the Road. Separation zones are intended to separate incoming and outgoing traffic and to be free of ship traffic. Separation zones should not be used except for crossing purposes. When crossing traffic lanes and separation zones use extreme caution.

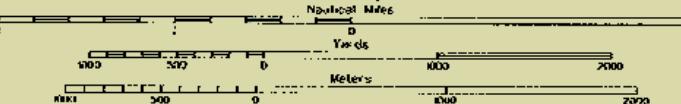
For information governing the VESSEL TRAFFIC MANAGEMENT AND INFORMATION SYSTEM for the coastal waters of southern British Columbia see Defense Mapping Agency Hydrographic Center Publication 131, Sailing Directions (proposed) for British Columbia, and the Sailing Directions, British Columbia Coast (Gold), Portion 1, published by the Canadian Hydrographic Service.



#### LOGARITHMIC SPEED SCALE

To find SPEED, place one point of dial on distance in miles (any unit) and the other on minutes run. Without changing dial spread, place right point on 60 and left point will then indicate speed in knots per hour. Example, with 4.0 nautical miles run in 15 minutes, speed is 16.0 knots.

#### SCALE 1:25,000



#### METERS

#### TIDE INFORMATION

Point	Latitude	Height referred to datum of soundings (M.L.W.)
Kanak Bay	48°29'N / 123°00'W	Mean High Water feet 7.3 feet 7.5
Roch Harbor	48°31'N / 123°09'W	Mean High Water feet 6.6 Mean Low Water feet 2.4 feet 2.5 Extreme Low Water feet -4.0 feet -4.0

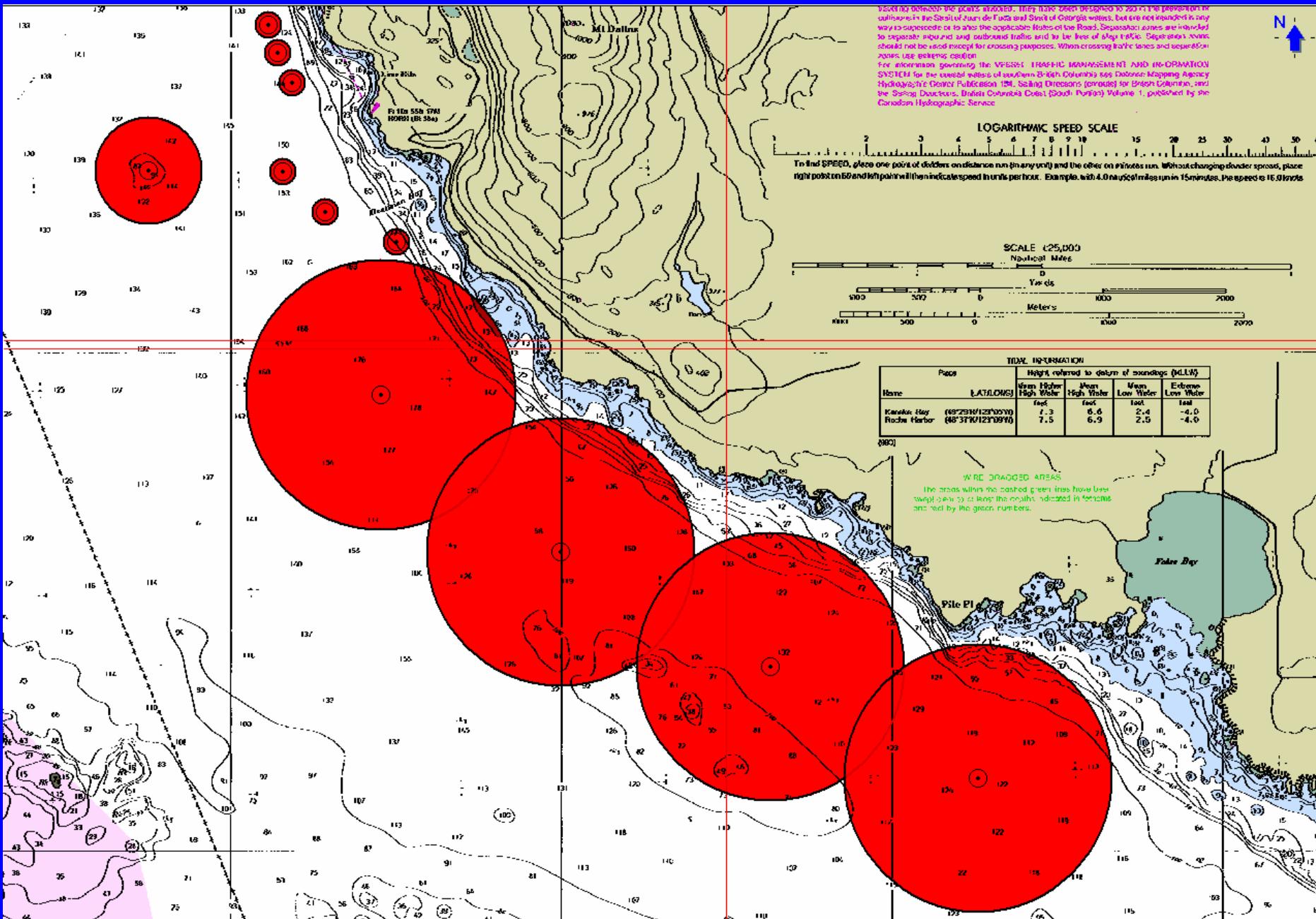
(80)

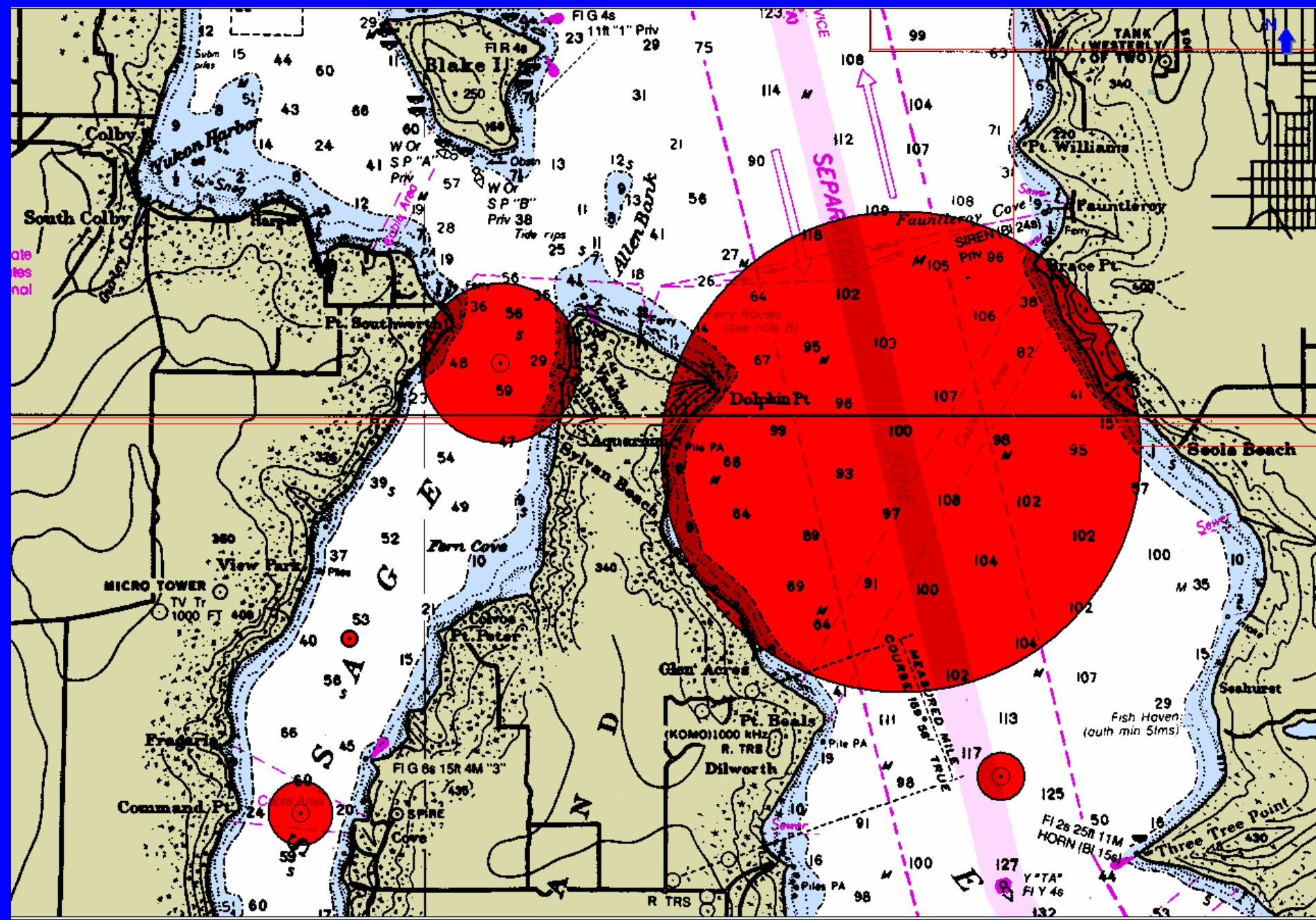
#### WRE DRAGGED AREAS

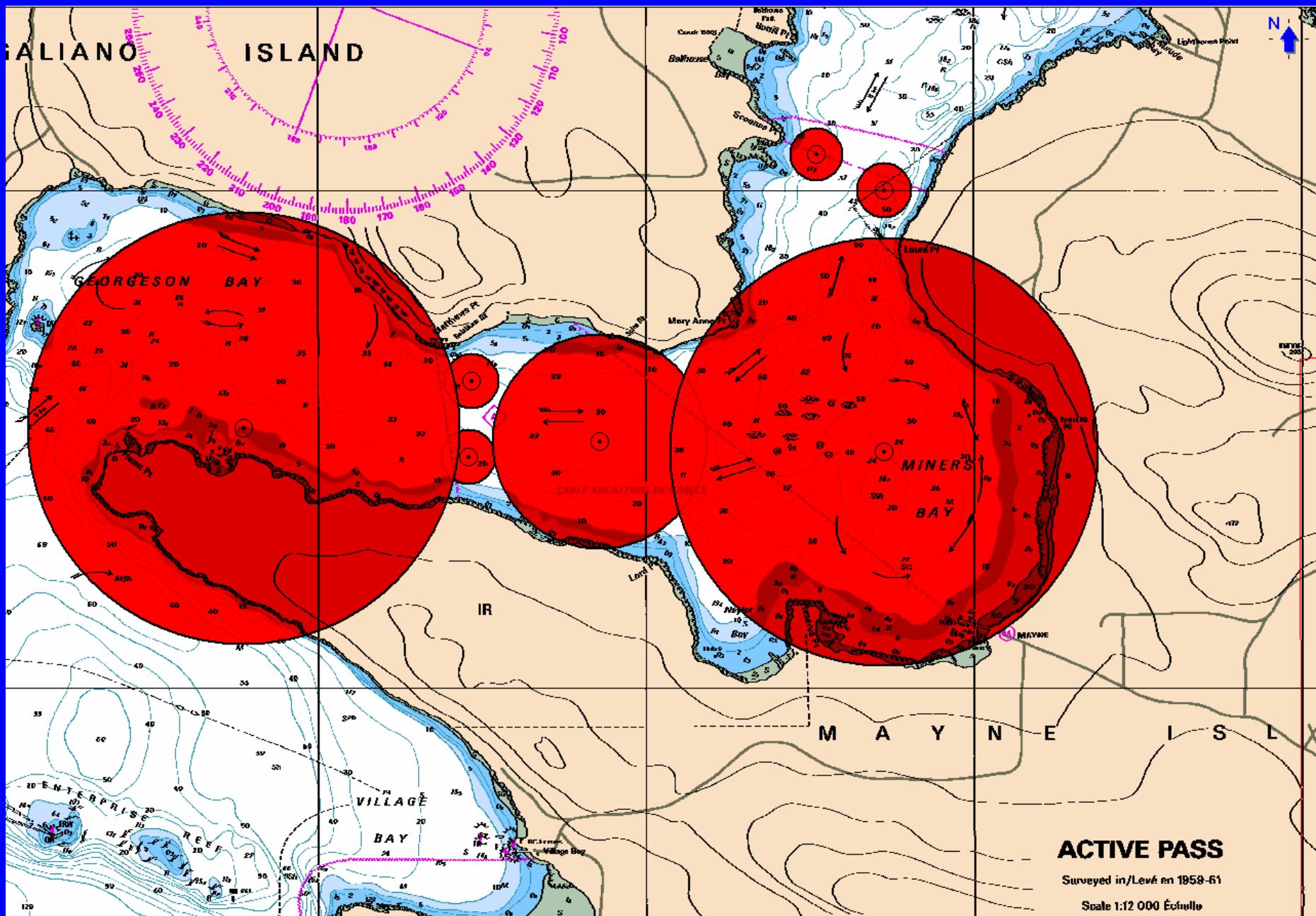
The areas within the dashed green lines have been swept away at least the lengths indicated in feet and set by the green numbers.

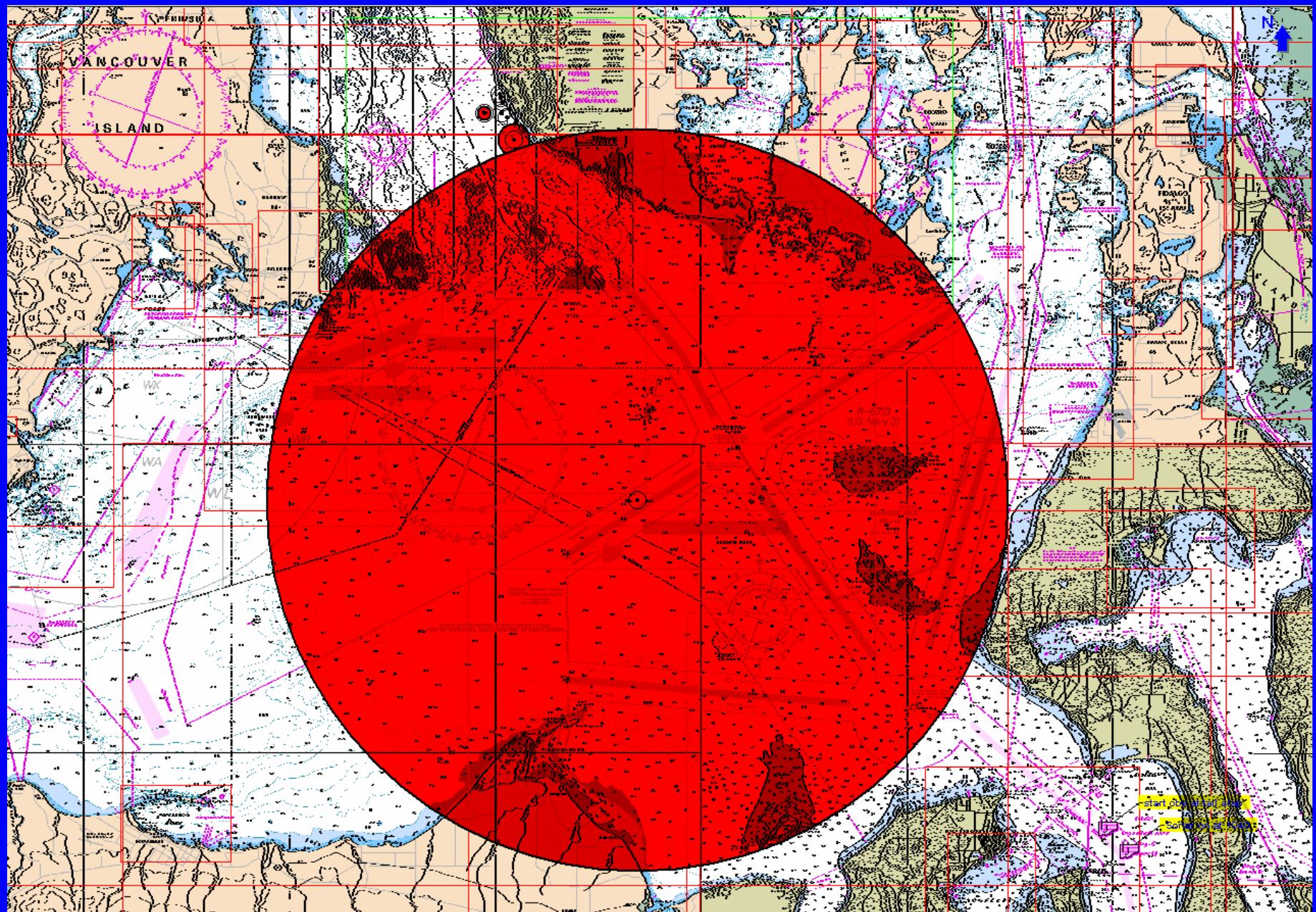
#### Pile Bay

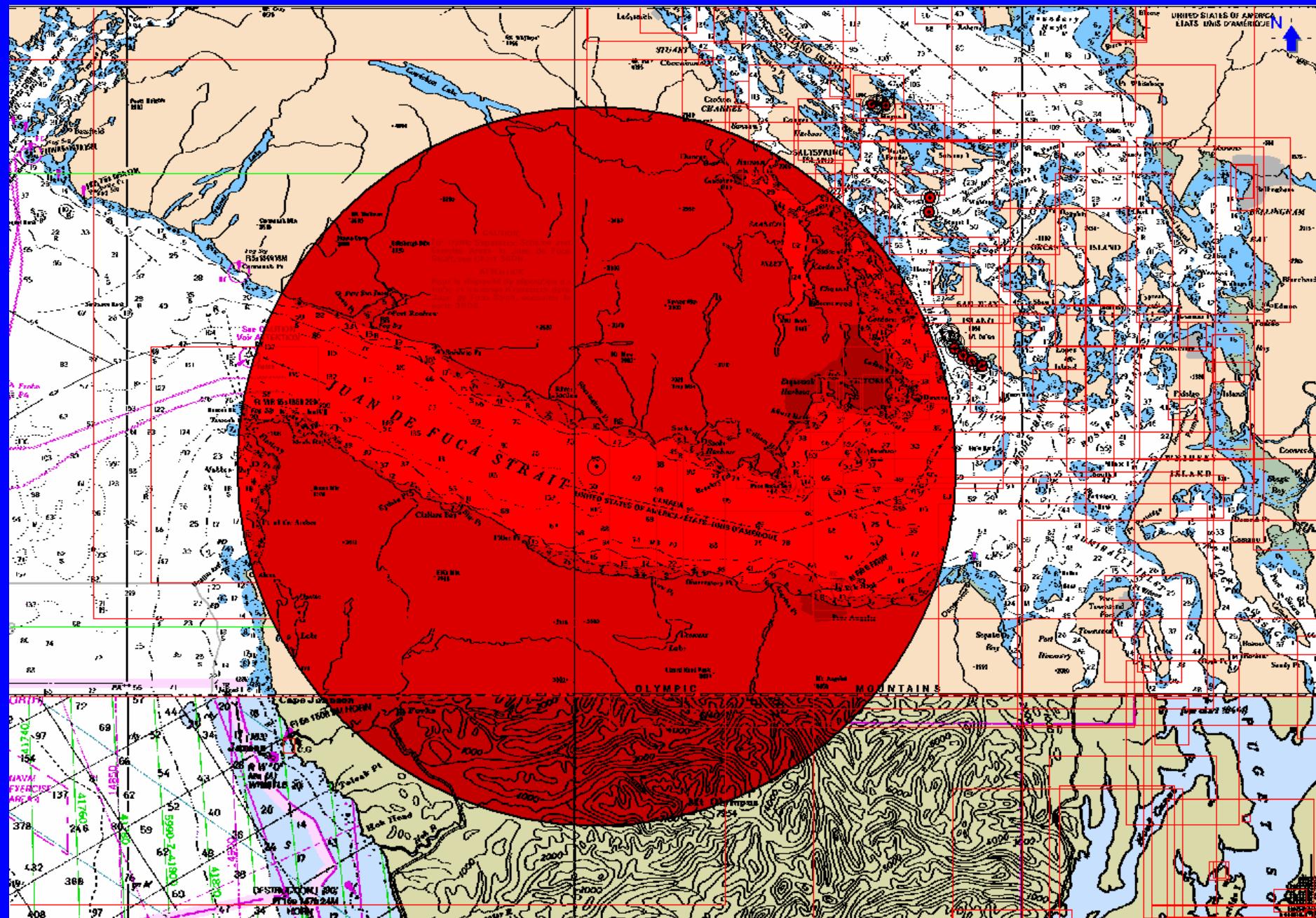
#### Pile Point

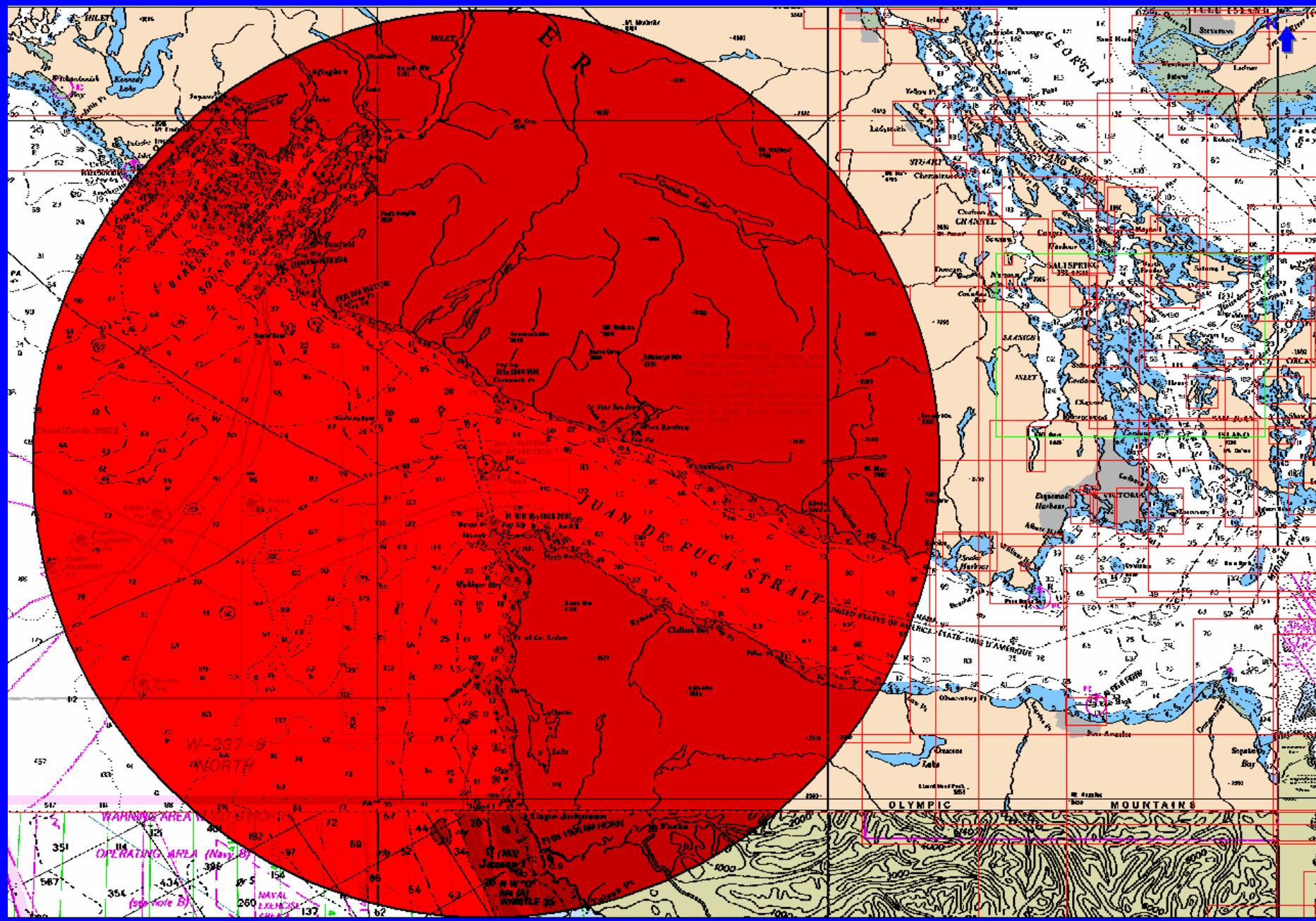




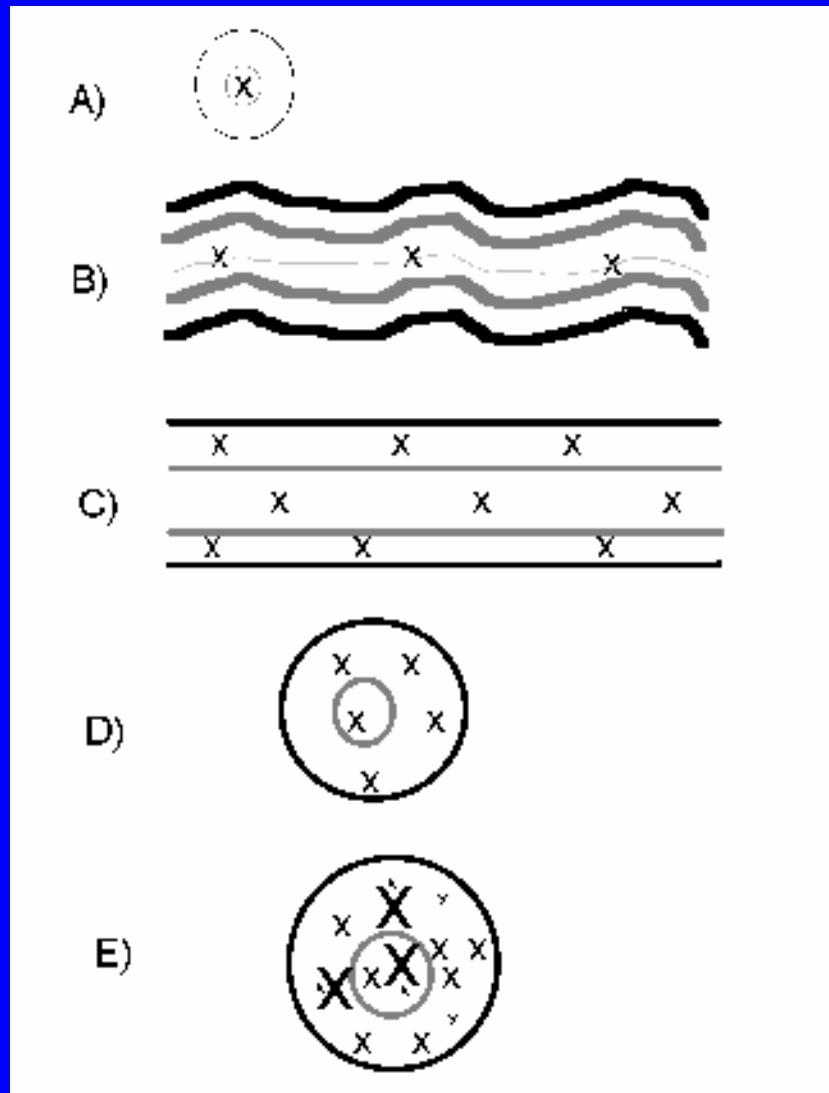




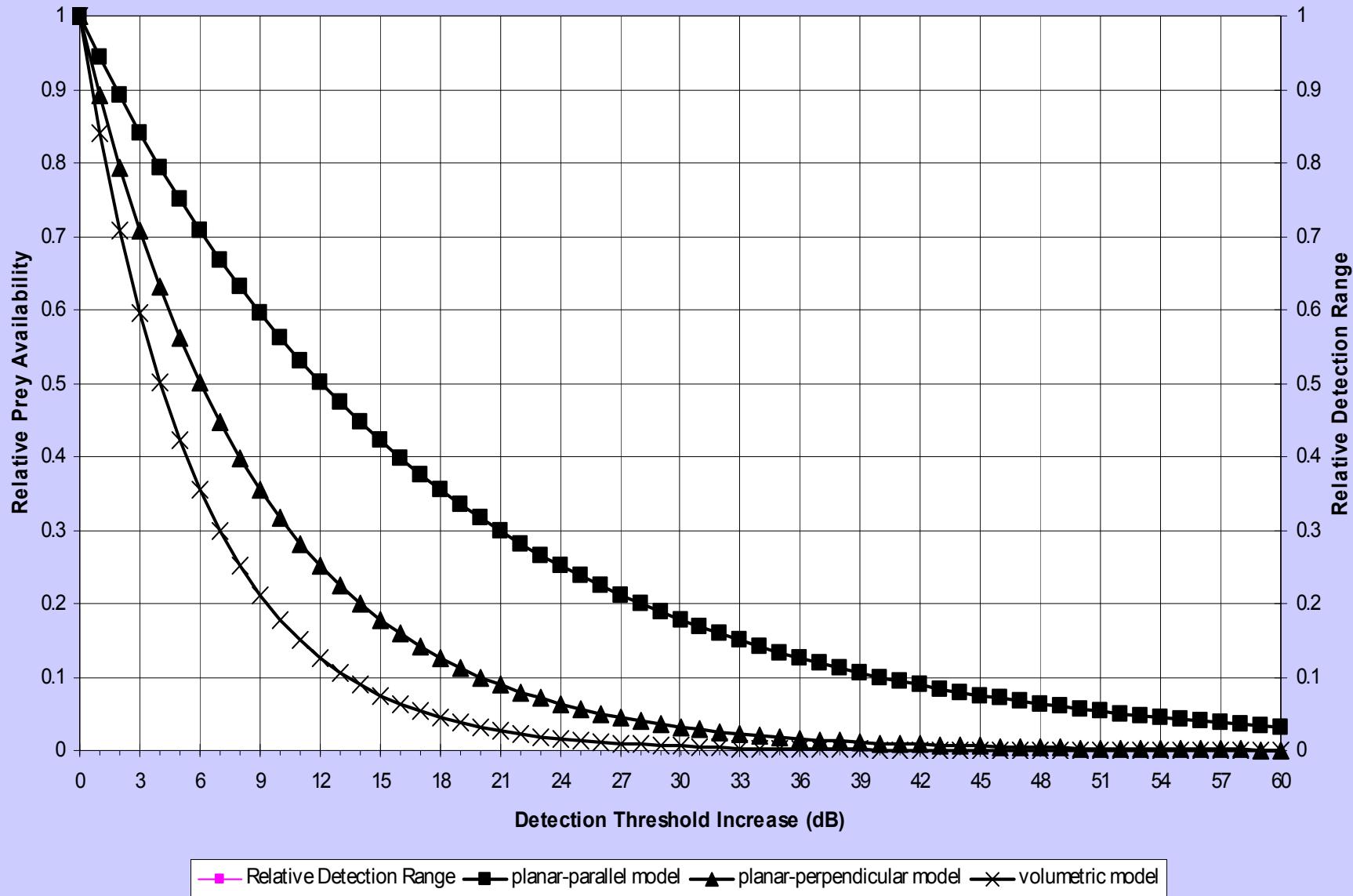




# Foraging tactics

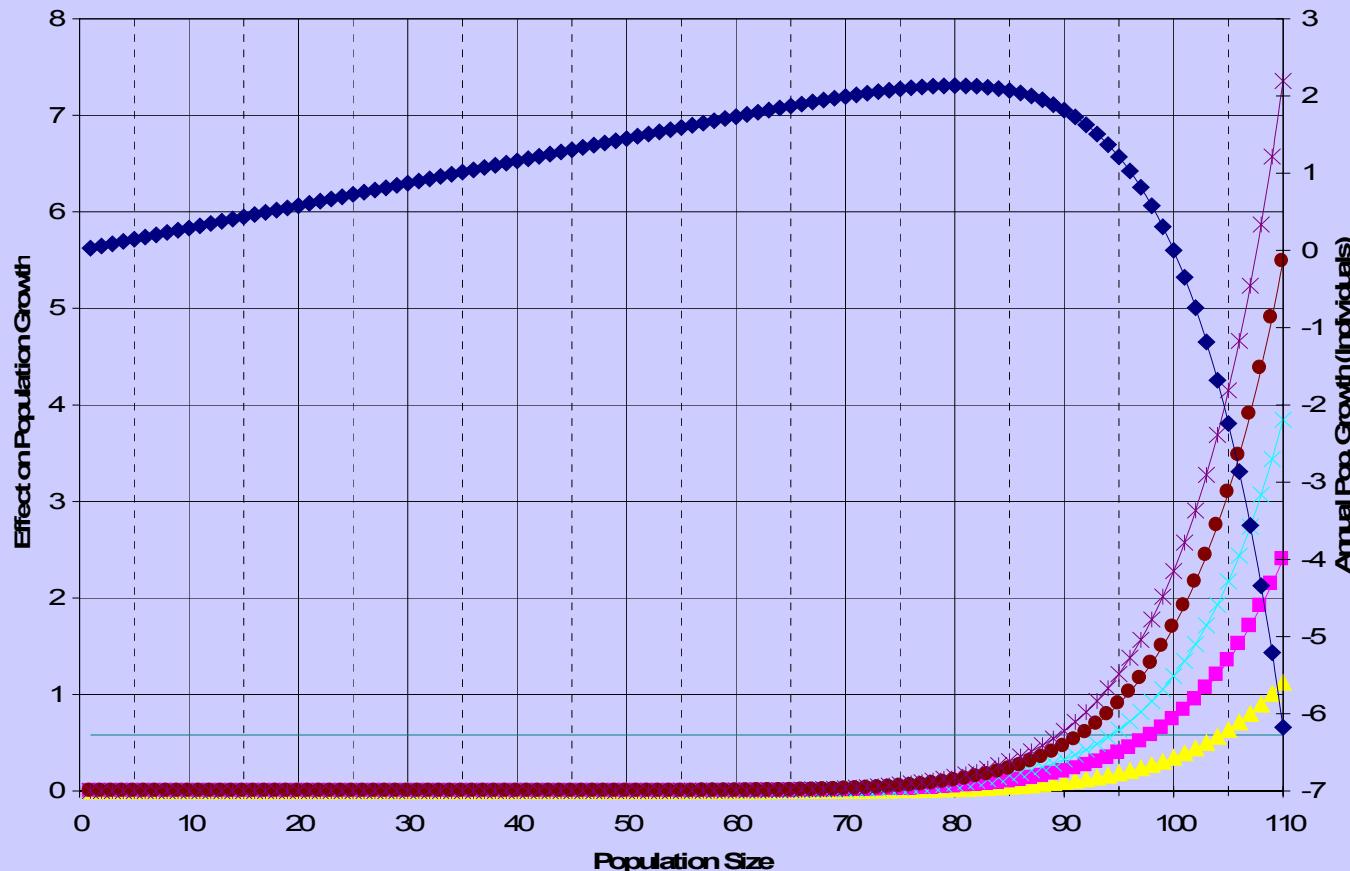


## Relative Prey Availability Due to Noise-Induced Threshold Changes



# Effects of Population Size and Cumulative Effect Size on Population Growth

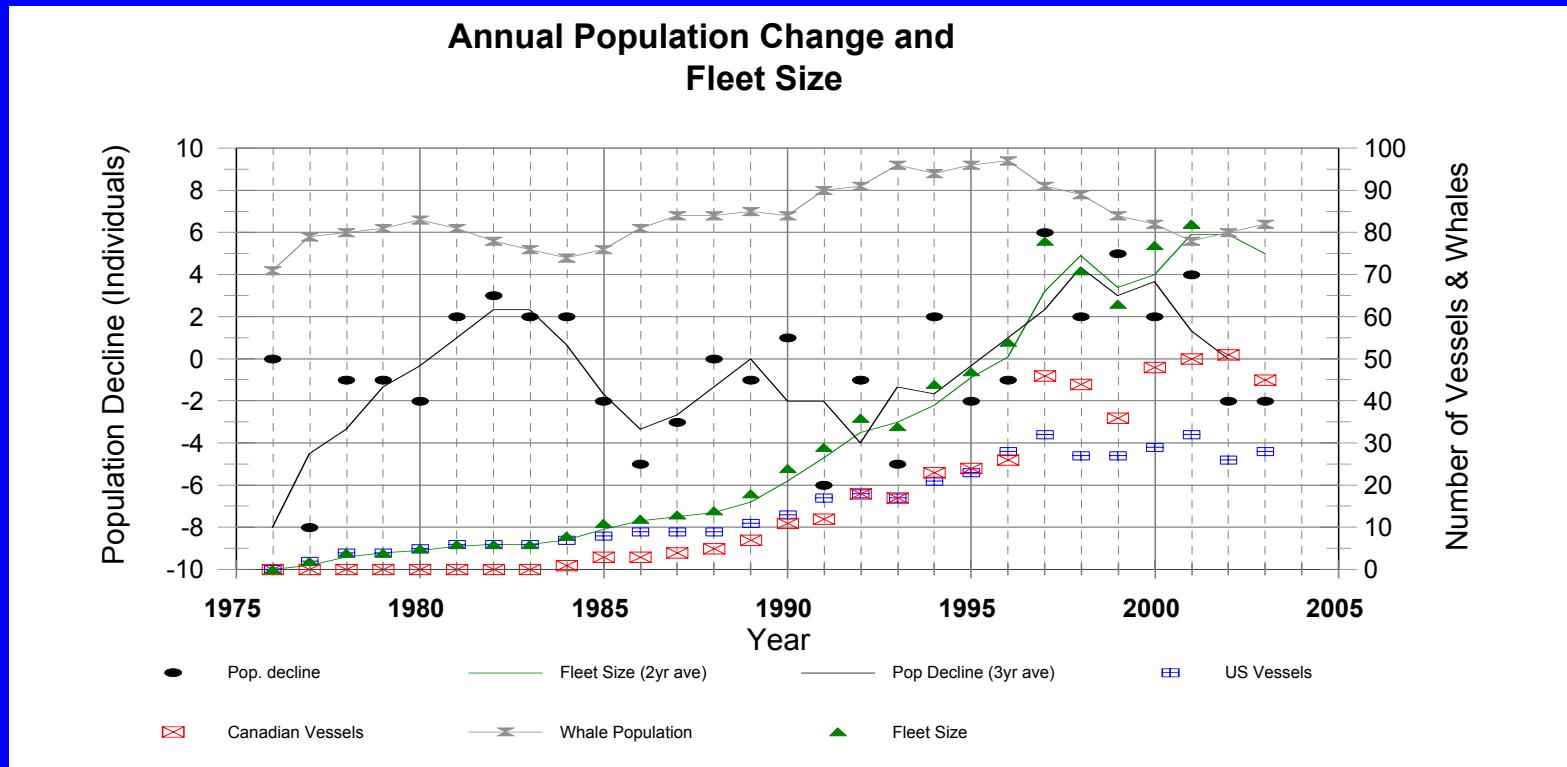
Effect of Whale Watching on Population Growth Rate  
(Shape Parameter = 11.3)



- negligible effects expected well below carrying capacity
- disturbance costly near carrying capacity

Bain et al. (submitted)

# Correlation ( $r^2=0.42$ , $p < .01$ ) of Fleet Size with Population Dynamics



- **Role in Decline**
  - Could account for much of recent decline in Southern Residents
- **Role in Recovery**
  - Toxins would slow recovery in Southern Residents
  - Recovery of fish stocks could offset effects of whale watching

(Bain et al.)

# Reducing the Cumulative Effect of Whale Watching

Total Quota Based on Potential Biological Removal

Limited Entry/Individual Transferable Quotas

License Fee to Cover Management Costs

Time and area closures

Changing operating practices to reduce impact

Quieter Vessels

Increasing Viewing Distance

Slowing Down Near Whales

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Orca Conservancy  
Orca Relief Citizens Alliance  
Friday Harbor Laboratories  
Whale Watch Operators Association NW  
NSERC  
Shell  
MEC  
Weber Fund  
WDCS  
TRFF  
IFAW  
Bion  
BC Parks  
DFO